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CONDUCTED BY

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Prof. Chem., Min., &c. in Yale Coll.; Cor. Mem. Soc. Arts, Man. and Com., Cor. Mem. Met. Soc., and For. Mem. Geol. Soc., London; Mem. Geol. Soc., and Hon. Mem. Lin. and Statis. Socs., Paris; Mem. Roy. Min. Soc., Dresden; Nat. Hist. Soc., Halle; Imp. Agric. Soc., Moscow; Nat. Hist. Soc., Belfast, Ire.; Phil. and Lit. Soc., Bristol, Eng.; Hon. Mem. Roy. Sussex Inst., Brighton, Eng.; Cor. Mem. of the Nat. Hist. Soc., and of the Archæolegical Soc., Athens, Greece; Lit. and Hist. Soc., Quebec; Mem. of various Lit. and Scien. Soc. in the U. States.

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## ERRATA.

P. 63, line 28, for carboniferous, read *carboniferous*—p. 64, l. 6, for that, read *that ;*—l. 27, for *marble,* read *rubble*—p. 65, l. 12, for *Ernest*, read *Calus*—p. 69, l. 19, for *their*, read *thin*—l. 29, for *Clair*, read *Plain ;*—p. 70, l. 8, for *Beeraft*, read *Becraft*—l. 16, for *lydian*, read *Lydian ;*—l. 17, for *bluffs*, read *bluff ;*—l. 26, for *equivalent*, read *equivalents*—p. 83, l. 11 from bottom, for *cholorate*, read *chlorate*—p. 85, l. 20 from bottom, for *crop-cleavage*, read *cross cleavage ;*—l. 13 from bottom, for *in a a*, read *into a*—p. 128, l. 18, 19, and 22, for *ounces*, read *ounce*—l. 2 from bottom, for *experimenters*, read *experiments*—p. 130, the letters A, B, and G. on fig. 2, are misplaced—p. 132, l. 20, after *latter*, read *describe*—l. 31, for *tinning*, read *turning*—p. 189, top, for *Mastodon Giganteum*, read *Mastodon giganteum*—p. 325, title, for *Dr.* BROWN, read *Dr.* BRONN.

*Cover*, for 32 Paternoster row, London, read 35.

*Correction.*—Since the communication of Dr. Sager was struck off, he has observed that the description of the Salamandra agilis had previously been published under another name. In the descriptions of the dental formulæ on p. 321, the reader will substitute the specific name *erythronota* for *agilis*, and *rubra?* for *erythronota.*

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*Remarks.*—This method of acknowledgment has been adopted, because it is not always practicable to write letters, where they might be reasonably expected; and still more difficult is it to prepare and insert in this Journal, notices of all the books, pamphlets, &c., which are kindly presented, even in cases, where such notices, critical or commendatory, would be appropriate; for it is often equally impossible to command the time requisite to frame them, or even to read the works; still, judicious remarks, from other hands, would usually find both acceptance and insertion.

In public, it is rarely proper to advert to personal concerns; to excuse, for instance, any apparent neglect of courtesy, by pleading the unintermitting pressure of labor, and the numerous calls of our fellow-men for information, advice, or assistance, in lines of duty, with which they presume us to be acquainted.

The apology, implied in this remark, is drawn from us, that we may not seem inattentive to the civilities of many respectable persons, authors, editors, publishers, and others, both at home and abroad. It is still our endeavor to reply to all letters which appear to require an answer; although, as a substitute, many acknowledgments are made in these pages, which may sometimes be, in part, retrospective.—*Eds.*

### SCIENCE.—FOREIGN.

Important facts embracing many results in Chemistry, by Thomas Exley, A. M. London, 1837. From the Author.

Lethea Geognostica, by Prof. H. G. Bronn, the last Livraisons, with the index and table of contents. Author.

Observations on some new Organic Remains in Flint of Chalk, by Rev. J. B. Read, M. A., F. R. S. London, 1838. From G. Mantell, Esq.

Works of Confucius in Chinese, from the Rev. Mr. Dickinson, American missionary, for the Library of Yale College.

Notice of the Indian Archipelago, and adjacent countries, by J. H. Moor. Singapore, 1837, Vol. I, Quarto, for the Library of Yale College, from Rev. J. F. Dickinson, Singapore.

Chart, exhibiting the plan proposed by Lieut. John Fayer, R. N. Commander of the steamship Liverpool, for extinguishing by steam, fires arising from spontaneous combustion of coals in other parts of a vessel. January, 1838. From Messrs. Abraham Bell & Co., consignees of the Liverpool steamship, New York.

British Annual and Epitome of the Progress of Science, for 1839. Edited by Robert D. Thomson, M. D. London. Hippolyte Bailliere, 1838. From the Author.

Consistency of the Discoveries of Modern Geology with the Sacred History of the Creation and the Deluge, by Prof. Silliman of Yale College. Reprint by J. S. Hodson, 112 Fleet st. London, 1837. Mr. Hodson.

The Seventh Report of the British Association for the Advancement of Science, Vol. VI. From the Association. London. John Murray, 1838.

Transactions of the Society for the Encouragement of Arts, Manufactures and Commerce, Vol. LI, Part II, and Vol. LII, Part I. From the Society through A. Akin, Esq. London, 1838.

Institution of Civil Engineers. Minutes of Proceedings and Sessions 1838 and 1839, pp. 52 and 26. London, 1838, 1839. From the Institute of Civil Engineers.

Palmer's New Catalogue of Chemical and Philosophical apparatus. Several copies. London, 1838. From Mr. Palmer.

A Catalogue of Ancient and Modern Botanical Books, offered for sale by O. Rich. From O. Rich.

Henry Coxhead's Catalogues of New Scientific Books.

The Silurian System founded on Geological Researches, in the Counties of Salop, Hereford, &c., with descriptions of the Coalfields and overlying formations, by Roderick Impey Murchison, F. R. S., F. L. S., in two parts, 4to., including an atlas of drawings and large separate maps. From the author. London, John Murray, Albermarl st. 1839. A magnificent work.

Part of the Poissons Fossiles of Prof. Louis Agassiz. From the author. Neuchatel, Suisse, 1839.

Monographies D'Echinodermes Vivans et Fossiles, par L. Agassiz. 1 Livraison Contenant les Salenes. Neuchatel, 1838. From the author.

Bulletin de Soc. Geologique de France. Tome ix, pp. 145 to 508. From the Society.

On the Geological Relations of the South of Ireland, by Thomas Weaver, Esq., F. G. S., R. S., &c. From the author, 4to. (from the Trans. Geol. Soc., London, Vol. V, new series, pp. 68.)

Dr. Mantell's Wonders of Geology. 2d London edition, 2 Vols. large paper. From the author.

Railway Mag. and Steam Nav. Journal, No. 29, for July, 1838, to No. 40, June, 1839, inclusive. From the Editor, John Herepath, Esq.

SCIENCE.—DOMESTIC.

Contributions to Electricity and Magnetism, by Joseph Henry, Prof. of Nat. Phil. in the Coll. of N. Jersey. Philadelphia, 1839. From the author.

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Boston Journal of Natural History; containing papers and communications read before the Boston Society of Natural History, Part I, No. 3, and Vol. II, No. 1. Boston, 1836 and 1839. From the Society.

The Alabama State Almanac for the year 1839. Tuscaloosa, Alabama. From Prof. Barnard.

An Essay on the Development and Modification of the External Organs of Plants; compiled chiefly from the writings of J. Wolfgang von Goethe. By Wm. Darlington, M. D. West Chester Point, 2 copies. From the Author—one for Yale Nat. Hist. Society.

Annual Report of the Geologist of Maryland. 1838. From the Geologist, Dr. Ducatel.

First and Second Reports of the Progress of the Geological Survey of the State of Virginia, for the year 1836 and 1837; by and from Wm. B. Rogers, Prof. Nat. Phil. in the University of Va.

Report of the Progress of the Geological Survey of the State of Va. for the year 1838; by Prof. Wm. B. Rogers. From the Author.

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Essay on Meteorological Observations; by J. N. Nicollet, Esq. Printed by order of the War Department, May, 1839. From Col. J. J. Abert, U. S. Engineer. Two copies.

New York Journal of Medicine and Surgery, July 1839. No. 1, Vol. I. From the Editors.

Third Annual Report of the Geology of Maine. From Dr. C. T. Jackson.

Address delivered on laying the Corner Stone of the Academy of Sciences of Philadelphia, May 25, 1839. From W. R. Johnson, Esq., Author.

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Account of a Tornado in Rhode Island; by R. Hare, M. D. From the Author.

Report of the Progress of the Geological Survey of New York, for 1839. One from Prof. Emmons, one from James Hall, and one from an unknown friend.

Second Annual Report on a Geological Survey of Ohio; by W. W. Mather. From Mr. Mather. Columbus, 1839.

Third Annual Report of the Geological Survey of Pennsylvania. From Hon. Judge D. Daggett; also one from N. Ellmaker.

Journal of the Essex County Nat. Hist. Soc. Vol. 1, No. II, 1839. From the Society.

Treatise on the Eye. By and from Dr. W. C. Wallace, oculist of New York.

## MISCELLANEOUS.—FOREIGN.

Scotch Life Assurance. From Mr. Fox of Durham, England.

Synopsis of a System of Education Established by the University of Kings College. Fredericton. New Brunswick, 1838.

Views of Clapham Common Eng. From Dr. Gideon Mantell.

View of the present state of Thames Tunnel. From the same.

Report on the Indians of Upper Canada. London, 1839.

Reports and Proceedings of the British and Foreign Aborigines Society. Four pamphlets from the Society. 1839.

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Catalogue of Bowdoin College, New Brunswick, Me. From Prof. Cleaveland.

Prospectus of the New York Quarterly Journal of Medicine and Surgery.

Circular of Irwinton Literary Institute. Irwinton, Alabama, 1839. From O. P. Hammond.

Annual Announcement of the Medical Department of Transylvania University, Lexington, Ky. 1839.

Circular of Rutger's Female Institute, New York. From Mr. C. E. West.

New York Literary Gazette, No. 64, containing Retzsch's Game of Life.

Barber's Historical Collections. Massachusetts. From the Author. 8vo, 1839. New Haven.

A Review of the Rev. Horace Bushnell's Discourse on the Slavery Question; by Francis Gillett. Hartford, 1839. From the Author.

Introductory Lecture to a Course of Chemistry delivered in Washington College, Lexington, Va. Feb. 21, 1838; by Geo. D. Armstrong, A. M., Richmond, 1838. From the Author.

History of the Old South Church in Boston; by Rev. B. B. Winslow, former Pastor of the Church. From Rev. J. W. Blagden, present Pastor.

Catalogue of a Collection of Rare, Curious and Valuable Books on Divinity, Classics, &c. to be sold 23d and 24th May at auction, by Bangs, Richards & Platt, N. Y.

Speech of the Hon. Thomas Morris of Ohio, in Senate of U. S. February 6th, 1839, in reply to Henry Clay. New York. From the Author.

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United States Naval Lyceum Report on the State of the Institution for 1839. From the Lyceum.

Constitution and By-Laws of the N. Y. Historical Society, 1839. From G. Gibbs, Esq.

A Catalogue of Miscellaneous Books for sale by Little & Brown, Boston, 1839. From the Publishers.

Annual Catalogue of the New England Agricultural Warehouse. Boston, 1839. From Joseph Breck & Co.

The School Advertizer. Several Nos. from Marsh, Capen, & Lyon. Boston, 1839.

Dr. Noah Webster's Address to the friends of Literature. From the Author.

Minutes of the Medical Society of Tennessee. Held in Nashville, May, 1839. Columbia. From the Society.

Mitchell's School Geography (with an atlas,) 12mo. Philadelphia, 1839. From Mr. Mitchell.

A Manual of Useful Studies for the Instruction of Young Persons. By and from Noah Webster, LL. D. New Haven, 1839.

Address at the opening of the Rutger's Female Institute, by Dr. Isaac Ferris. From the Author, and 1 from C. E. West to B. S., Jr.

Burmese Tract, called the Ship of Grace.

Twenty Third Report of the Directors of the American Asylum at Hartford for the Deaf and Dumb. Hartford, 1839. From Mr. Weld.

First Annual Report of the Commissioners of Common Schools in Connecticut. Hartford, 1839. From H. Beardsley, Esq., Secretary.

Catalogue of Historical, Antiquarian, and Scientific Books, sold in N. York, June 6. From the Auctioneers.

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Second Report of the Foreign Evangelical Association. New York, 1839. From Rev. Mr. Baird.

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Hartford Young Men's Society, Charter and By-Laws. From H. Barnard, Esq.

The Statutes of Emory College, and the By-Laws of the Faculty. Oxford, Ga. From Prof. A. Means.

Annual Report of the Regents of the University to the Legislature of the State of New York. 1839. From the Regents.

Annual Report of the A. B. C. F. M. for 1839. From the Board.

Proceedings of the American Philosophy Society. Philadelphia. Vol. 1. Nos. 4, 5 and 6. From the Society.

Second Annual Report of the Geology of Ohio. From C. B. Goddard, Esq. Also one to Yale Nat. Hist. Soc. From W. W. Mather.

13th Report of the Home Missionary Society, 1839.

### NEWSPAPERS.—FOREIGN.

The Atheneum Journal, Nos. 584, 585, 596, and 601. From Charles Fox, Esq.

### NEWSPAPERS.—DOMESTIC.

The Boston Atlas. Tuesday, April 16, with notice of sales of the late Dr. King's Electrical Apparatus.

New Era. Monday, March 25, 1839. From E. Williams. With a notice of Dr. H. H. Sherwood's memorial to Congress on Magnetism.

The Miner's Journal. Pottsville. March 30th, 1839. With a notice of the coal mines of the region. Mr. Wm. W. Selfridge.

N. Y. Daily Whig. Friday, April 12th.

East Tennessean. Rogersville. Tuesday, April 2d, 1839. No. 1. With a notice of the Marbles of Tennesse, by Dr. Troost.

New Orleans Commercial Bulletin. March 28, 1839. With a notice of J. S. Buckingham's Lectures.

Feliciana Republican and Louisana Literary Messenger. Saturday, April 6, 1839. Containing Prof. Cabis' Temperance Speech. From Prof. W. M. Carpenter.

The Colored American. Saturday, Jan. 29, 1839.

Report of the Public proceedings in New Orleans to establish a a Sailor's Home. N. O. Com. Bulletin of April 18th, 1839.

Boston Cultivator. May 11, 1839. From Hovey & Co. With a catalogue of new Dahlias, for 1839.

The Sun (of N. Y.) July 29. From Dr. Peck. Containing an account and drawing of the Steamer British Queen, and of Fitch's Steamboat of 1786, on the Delaware.

The Rockton Enterprise. Several Nos. From E. Griffing, Editor, Little Falls, (Rockton.)

The Cultivator for 1838–9. From Judge J. Buel. Albany.

The Weekly True American. N. Orleans. No. 59. Jan. 9, 1839.

Proceedings of the Broadway Tabernacle against Lewis Tappan.

Philadelphia North American. May 21st, 1839.

Friend of Man. July 3d, 1839.

N. Y. American. May 28th. With a notice of this Journal. From G. S. Silliman, Esq.

Family Schoolmaster. Richmond, Indiana, Jan 26th.

The Virginia Herald. Fredericksburg, Jan. 26th, 1839. With an account of the Russian mode of extracting gold. From James Williams, Esq.

Republican Farmer. Wilkesbarre, Pa. Jan. 26th, 1839. From E. J. Turner.

Norwalk Gazette, Conn. July 17. Containing remarks of Rev. John Noyes, on 4th July, 1839.

N. Y. Commercial Advertizer. June 7th, 1839. With a notice of Mr. Frelinghuysen's Inauguration as Chancellor of the University.

## SPECIMENS—FOREIGN AND DOMESTIC.

Beautiful Quartz Crystals from Little Falls, N. Y. From E. M. Griffing.

Two caskets of dried plants from Indiana, for the Yale Natural History Society. From Mrs. L. W. Say.

Sulphate of Strontia from Sicily. Miss Pratt, Summer st., Boston.

Section of an Elephant's tooth. From Mr. J. E. Pratt, Boston.

A box of impressions of fossil plants from Alabama. From Prof. F. A. P. Barnard, Tuscaloosa, Alabama.

A box of Encrinites from the transition near New Echota, Ga. From W. J. Parvin, Esq., P. M.

A suite of Geological Specimens from S. Africa, near Capetown. From Rev. George Champion. The box also contained several other articles of interest in Botany and other parts of Nat. Hist.

Beautiful Beryls from Haddam, Ct. From Prof. J. Johnston, Wesleyan University.

A box of Chinese curiosities. From Rev. Dr. Parker, Canton, China. This box was detained in N. Y. Custom House, six mo's. or it would have been sooner noticed.

An Alligator in alcohol, from S. Carolina. W. T. Hatch, Esq.

Several rare Cape Bulbs Gladiolus Ixia Sparaxis, and also seeds and flowers of several species of Zeranthemum Ammobum, &c. From Rev. George Champion, through Mrs. J. Bliss, Boston.

A box of Fossils from Niagara. From Mr. Strong.

Box of Bituminized Wood from the banks of the Mississippi. From Prof. Carpenter, Jackson College, La.

Box of Fossils from Alabama. From Miss Shedden to Yale Nat. History Society.

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## NEW EDITION OF DR. MANTELL'S WONDERS OF GEOLOGY.

A full notice was given of this work in our Vol, xxxiv, p. 387, and we announced in Vol. xxxv, p. 384 that arrangements had been made with the author and his publishers, by which Mr. A. H. Maltby of New Haven would publish the new edition in this country as soon as it could cross the ocean, and that by the author's approbation it would appear under the direction of Prof. Silliman, with introductory remarks by him; the proper type and illustrations to be identical with those of the London edition. This work is now received in an enlarged and improved edition: it has 10 plates and sections, of which six are colored, and nearly 100 additional engravings. While it is full and exact in science, it is without doubt the most attractive and interesting work on Geology which has ever been published. It does not interfere with the excellent treatises of Bakewell, Lyell, Murchison, De la Beche, Daubeny and other eminent geologists; it occupies a peculiar niche of its own, and reflects both the image of geological nature and of the author's own elegant and accomplished mind. Without any other than a friendly interest in these volumes, we cordially recommend them, as being equally instructive and delightful.—*Eds.*

THE

# AMERICAN JOURNAL OF SCIENCE, &c.

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ART. I.—*Meteorological Observations during a Residence in Colombia, between the Years* 1820 *and* 1830.* By Colonel RICHARD WRIGHT, Governor of the Province of Loxa, and Confidential Agent of the Republic of the Equator, &c. &c.

IF the materials of science could be gathered only by the scientific, the following collection of observations would be a useless labor; but it frequently happens that, in distant countries, the opportunity of observing natural phenomena falls to the lot of those very ill fitted in most respects to profit by it. The genius of Humboldt, like an incantation of science, descends upon the New World but once in a series of ages. The most that can be done by an ordinary observer, is to offer his mite,—a single stone towards the pyramid of knowledge,—in the hope that he may casually prove useful; and with such humble pretensions can scarcely be deemed importunate. Should even this apology barely extenuate the sterility of a ten years' residence in a country so admirably varied and rich in natural phenomena as Colombia, something farther may be urged in excuse of the *military* traveller, obliged frequently to *hurry* through the most interesting parts, and to vegetate whole years in others of minor importance; without books, without instruments, without resources; fettered too often by the chain of his own daily wants and sufferings; and

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* From the London and Edinburgh Philosophical Magazine and Journal of Science, Vol. 14, No. 85, January, 1839.

fallen on a time when every species of local and traditional information, every glimmering of philosophic research had been buried and obliterated amid the storms and struggles of the revolution.

The geographical features of Colombia have been portrayed by Humboldt with an accuracy which renders further description superfluous. It is, however, impossible to traverse this extensive territory, without being struck by the physical phenomena of a country where *height* produces the effect of *latitude*, and where the changes of climate, with all the consequent revolutions of animal and vegetable life, are brought about by localities to which we find little analogy in Europe. The equatorial seasons, as is well known, are merely the wet and dry; and though the Spaniards, influenced by European recollections, have given the former the name of winter *invierno*, it is during this period that nature revives from the vegetative torpor which the scorching tropical heats produce in the lowlands in almost an equal degree with the frosts of northern climates. In the vast plains which extend to the south and east of the great chain of the Andes, the rainy season observes an invariable order. The Orinoco begins to rise in April, and attains its maximum of increase in July and August, when the immense savannas which extend to the base of the Andes are converted into the appearance of an inland ocean. It decreases from this period, and the summer is reckoned from October to April. In the mountains, on the contrary, the rains commence about the former month, and predominate, with intervals of fair weather, till May or June. The winter of the low lands, to the west and north of the Cordillera, both on the Pacific and Atlantic coasts, is governed by that of the mountains, but with several curious localities. Thus, the rainy season of Guayaquil is nearly as regular as that of the plains, being reckoned from the middle of December to the middle of May; while the thick forests, which further to the north cover the provinces of Esmeraldas, Barbacoas, and Choco, produce, by their coustant evaporation, an almost perpetual deluge. Wherever, on the contrary, the Cordillera recedes to some distance from the coast, as is the case with parts of the Venezuelan chain, the intermediate country is parched often by a drought of several years. Maracaybo, and a considerable part of the province of Coro, are instances where sandy plains, scantily shaded by *Mimosas* and

thick plants, afford shelter and subsistance only to flocks of goats and asses. The coast of Rio Hacha is equally dry and sterile, till it approaches the foot of the isolated ridge of Santa Marta; while the Goagira territory, situated betwixt Rio Hacha and Maracaybo, is regularly inundated every year, and consequently, though destitute of streams, maintains considerable herds of cattle and horses; a circumstance to be ascribed to the vicinity of the Ocaña branch of the Andes, which extends, with its clouds and thick forests, almost to the confines of this province. The whole Peruvian coast from Payta to Lima, is an additional instance of the same fact, where the recession of the Andes from the coast is marked by sandy deserts, which the industry of the Incas had rendered productive by artificial irrigation. In the valleys and on the table lands of the mountains themselves, the culminating summits produce great variations in the distribution of moisture. The city of Caraccas, situated at the foot of the Silla, has the benefit of a regular though mild rainy season, while within a league there are spots which suffer several years of drought. Popayan, placed at the head of a sultry valley of the Cauca, and surrounded by lofty *paramos*, has nine months of continued rains and tempests, attributable to the clouds which are driven in opposite directions from the mountains till they encounter the hot ascending air of the valley. In the ancient kingdom of Quito, now called the Republic of the Equator, the mass of Chimborazo interrupts the passage of the clouds from south to north; so that, while the western slopes are deluged with rain, the elevated plains of Riobamba to the east recall to the imagination of the traveller the deserts of Arabia Petræa. Following the same mountain chain towards the city of Quito, we observe the storms arrested between Cotopaxi and Pichinca, over the valley of Chillo; while two leagues farther to the north, the climate of the village of Pomasqui is so dry as to have given it the name of Piurita (little Piura.)

The manner in which rain is formed and precipitated at various elevations, seems to illustrate and confirm the theory of Leslie. In the region of *paramos*, i. e. from 12,000 feet upwards, the encountering aërial currents, unless in the case of some strong agitation of the mass of surrounding atmosphere, are of low and nearly equal temperature. The rains in consequence assume the form of thick drizzling mists, known by the name of *paramitos*.

On the elevated plains we find the showers more or less sudden and violent, according to localities which give rise to a mixture of currents more or less variably heated. Quito, for example, is situated on what may be called a *ledge* of the lofty mountain of Pichincha, and overlooks the valley of Chillo of Guaillapamba, furrowing the adjacent table land, on which the thermometer often rises to 80° in the shade. The encounter of portions of the atmosphere, thus variously heated, produces showers as sudden and heavy as those which generally distinguish tropical climates. On the slopes of the Cordillera the rains are generally violent for the same reason. Looking to the hygrometrical state of the atmosphere, as it results from observations made on the table lands of the equator and the coast of the Pacific, we find it to vary from 0° in the damp forests of Esmeraldas to 97°·1 on the elevated plain of Cayambe; the experiments in both places being made during June and July, the summer months both of the coast and mountains. The average medium for the low lands is 23°·85; for the Cordillera 44°·36 of the hygrometer constructed upon Leslie's principle; but we are in want of sufficient *data* for those elevations which approach to the limit of perpetual snow. To judge, however, from a small number of observations made on the mountain of Cayambe at 12,705 and 14,217 feet of elevation, and at the hut of Antisana at 14,520 feet, where the hygrometer was found to give 16°·5, 13°·9, and 30.°3, it would not seem that the dryness of the atmosphere increases in ratio of the elevation; at least, in the neighborhood of snowy mountains, where a continual moisture is exhaled, and heavy mists sweep over the soil towards evenings even of the fairest days.

To estimate the general distribution of temperatures through the vast territory of Colombia, we may conveniently consider it as divided into five zones. 1st. That of the level, or nearly so, of the ocean. 2nd. That of the small elevations, from 500 to 1,500 feet. 3rd. That of the slopes of the Cordillera, from 2,000 to 7,000 feet. 4th. That of the elevated plains, or table lands, from 8,000 to 10,000 feet; and 5th, That of the *paramos*, from 11,000 feet to the limit of perpetual snow.

1. The degree of heat at or near the level of the ocean is modified by a variety of local circumstances, which may be ranged under the following heads: proximity of the sea; of great rivers and lakes; of lofty ridges of mountains; of extensive forests; of

contiguous elevations which impede the circulation of air, and produce reflected heat. The various combinations of these circumstances may be considered as affording a rule of the increase or diminution of temperature. Thus, La Guayra, situated on a sandy beach backed by a perpendicular wall of rocks, has no counterpoise to the excess of heat but the sea breeze, and the remote influence of the ridge of the Silla, which no where reaches the limit of perpetual snow. Humboldt considers it in consequence as the hottest place on the shores of the New World, (Personal Narrative, vol. iii, p. 386,) the mean annual temperature being 82°·6; yet the observations I made during some months' residence in Maracaybo give an annual mean of 84°·63. Nor is this surprising, when we consider the localities of both places. In Maracaybo the sun's rays are reflected from a barren sandy soil, scantily sprinkled with *Mimosas* and prickly plants. The mountain chains are too remote to have any influence on the atmosphere, so that several years frequently pass without any regular fall of rain. The vicinity of the lake, no doubt, acts slightly as a refrigerant; but the city is built on the border of its outlet to the sea, where it is both narrowest and shallowest, and is consequently heated nearly to the temperature of the incumbent atmosphere. Add to this, the small sandy elevations to the north, which intercept the partial effect of the sea-breezes, so that they are scarcely felt, except in the months of December and January, when the thermometer sometimes sinks to 73°; yet the medium even of these two months is not less than 81°; while that of La Guayra from November to December at noon, is, according to Humboldt, 75°·8, and at night 70°·9. (Personal Narrative, vol. iii, p. 387.) Rio Hacha is situated on a sandy beach; the sea-breeze blows with such violence that boats can scarcely land between ten in the morning and four in the afternoon. These winds, however, sweeping over the hot plains of Coro and Maracaybo, have but a partial effect in lowering the temperature, the annual mean of which is 1°·98 less than that of Maracaybo. I never saw the thermometer lower than 75°, nor above 89°. In Santa Marta the average of the coolest months is 82°·25. The thermometer, however, never rose during my residence there above 87°. The soil is sandy, and the city is surrounded by bare rocky heights to the north and south, which counterpoise the cooling influence of the *Sierra nevada*, (snowy mountains,)

from which it is but a few leagues distant. The temperature of Barranquilla, a village situated on the river Magdalena, about eighteen miles from its mouth, is nearly the same with that of Santa Marta; for if, on the one hand, the air is refreshed by the evaporation from a damp soil covered with luxuriant forests and the vicinity of a large river, on the other, it is beyond the reach of the sea-breeze, and the influence of the mountains which operate in Santa Marta. The annual mean is 82°·20. That of Cumana is, according to Humboldt, 81°. The breezes which sweep from the gulf of Paria over the wooded Brigantine chain, probably contribute to lower the temperature.

We have thus, on a calculation of six points on the Atlantic coast of Colombia, a mean annual temperature of 82°·56.* The shores of the Pacific, as far as the latitude of Payta, are subjected to other influences, being almost entirely covered by damp, luxurient forests; while the ocean itself is cooled, as Humboldt observes, by the winds which blow continually from the south. This, however, is more perceptibly the case from latitude 8° to to 13°, where the air is cooled to an average of 71°·8 (Humboldt *De Distributione Geog. Pl.* p. 92.) Betwixt 9° N. lat. and 3° S. lat. if we may trust to observations made at the five points of Panamà, Esmeraldas, El Morro, the island of Punà, and Guayaquil, the annual mean is 80°·11, being 2°·45 less than the mean of the Atlantic coast. A notable difference also arises from the superior elevation of the Pacific chain of the Andes, and its more immediate vicinity to the coast, while the Venezuelan branch, with the exception of the Santa Marta ridge, is both lower and more inland. A curious exception to the general temperature of the Pacific coast, may be found on passing Punta Galera and Cabo San Francisco (lat. 50′ N.) to the south. The sky is here almost perpetually clouded, and a drizzling rain falls through the greater part of the year. During a week I passed there I never saw the sun; and the average temperature was only 74°·14. This was the more striking, as along the coast, immediately to the north of Punta Galera, the weather was constantly dry and the sky clear. The miry state of the road across the point of the Cape of

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* I have not included Cartagena, because the number of observations is perhaps too limited to draw a conclusion as to the yearly temperature. If we take them into the calculation, the annual mean would be 82°·86, which is probably too high.

San Francisco indicates the line of separation betwixt two distinct climates. It will be seen by the map, that from P. Galera the coast, after running nearly due west, turns abruptly to the south.

2. On penetrating into the interior of the country, and examining the temperature of small elevations, we may take, as forming an aggregate specimen of the whole country: 1. The damp wooded valleys of the Orinoco and Magdalena; 2. The forests which border on the Pacific; and 3. The immense plains of Venezuela, alternately flooded and parched with excessive heat. Humboldt assigns to the valley of the Orinoco a mean temperature of 78°·2. The small number of observations I have made on that of the Magdalena, would give a mean of nearly 83°, which I should scarcely think too high, considering the localities of the river, which, flowing from south to north, affords no channel to the sea-breezes. Its mass of water is also much less considerable than that of the Orinoco; while its numerous sinuosities, and the low ridges which border it in the upper part of its course, contribute to render the air stagnant and suffocating. The temperature of Honda, at 1,200 feet of elevation, is as high as that of any part of the coast except Maracaybo. The unbroken forests which extend from the roots of the Quitenian Andes to the shores of the Pacific have a much lower temperature, caused by the proximity of the snow-capped Cordillera, and the humidity which prevails throughout the year. Accurate observations give an annual mean of 76°·78, or 1°·42 lower than the valley of the Orinoco, and 6°·22 lower than that of the Magdalena. The mean temperature of the plains of Venezuela is reckoned by Humboldt at 88·4, (*De Distributione Geog. Plant.* p. 92.;) yet several reasons may induce the belief that this calculation is excessive. This illustrious traveller performed his journey during the summer season, when the atmosphere is heated by the reverberations from a parched and naked soil. Persons who have resided near the Apure, state the climate in rainy weather to be cool, and refreshed by a constant breeze. It is only on the coast of the Pacific that the rainy season is the period of the greatest heat, when the air is still, and undisturbed by those electric explosions so common on the mountains and in the interior. The observations I made at Varinas and San Carlos, towards the beginning of the winter season, give a mean of 81°; and averaging

the dry season at 88°·4, we have a yearly mean of 84°·7, which is probably the extreme, or something beyond it. There is no doubt it is in the plains of the interior we find the greatest heat during the dry season. In the level country, called the valley of Upar, betwixt the mountain ridges of Santa Marta and Ocana, I found the thermometer in the shade several times above 100°, and once as high as 108°. The average of nineteen observations made at different points of this district is 89°·9; but we must allow a considerable decrease during the months when the soil is covered with thick vegetation, and drenched by continual rains. As a general mean of the interior, at small elevations, we may take 80°·67, or nearly that of Cumanà.

3. The temperate mountain region lies nearly betwixt the elevations of 3,000 and 7,000 feet. Below this may be considered as a hot climate, such, for instance, as Valencia and the valleys of Aragua in Venezuela, the height of which is from 1,500 to 2,000 feet, and its mean temperature 78°, or 0°·24 above that of Guayaquil on the Pacific; but the soil, stripped by cultivation of its ancient forests, imbibes freely the solar rays, which are besides reflected from the rocky elevations which every where surround the cultivated districts. The temperature of Caraccas (elevation 2904 feet) was fixed by Humboldt in his Essay *De Distributione Geographica Plantarum*, p. 98, at 69°·6; but in his Personal Narrative, b. iv, c. xii, p. 460, he considers 17°·2 of Reaumur = 70°.40 of Fahrenheit, nearly as the true yearly mean. My own observations during a residence of some months give 71°·40. The preference would be certainly due to Humboldt's calculation, but for some collateral circumstances deserving attention. I heard it generally remarked in the city, that the seasons had grown *hotter* since the earthquake of 1812. It would be difficult to explain how the temporary evolution of volcanic gases, supposing such to have taken place, could operate any permanent change on the surrounding atmosphere; yet other causes may have produced an effect falsely ascribed to the phenomenon most impressed on the imagination of the inhabitants. On looking over Humboldt's collection of observations for December and January, 1799, we find the thermometer seldom rise to 75°, and often sink to 59°; so that the mean of these months is about 68°. During the same months in 1821, the daily range was from 65° to 76°. I never observed it lower than 61°·5, and on one occa-

sion, at 5 a. m., it stood at 61°·0. The mean of these two months is 70°·21, or 2°·21 higher than the estimate of Humboldt. The clearness and beauty of the sky, during almost the whole period of my residence, is also a circumstance opposed to Humboldt's "*cœlum sæpe nubibus grave quæ post solis occasum terræ appropinquant.*" *De Distributione Geog. Plant.* p. 98. I remember but once to have seen a fog in the streets of the city. Future observations will show whether any change of climate has really taken place, or whether the differences observed be only such variations as may be frequently remarked in the same place betwixt one year and another. The mean of the whole temperate mountain region may be reckoned at 67°·80; that is, if we limit ourselves to the districts partially cultivated and inhabited. The declivities of the Andes, still covered with vast and humid forests, have probably their temperature proportionably lowered. Thus the village of Mindo, on the western declivity of Pinchinca, embosomed in humid forests, at 3,932 feet of elevation has a medium temperature of 65°·5, the same with that of Popayan.

4. The elevated plains of the Andes, betwixt 8,000 and 11,000 feet, on which were anciently united the most powerful and civilized indigenous nations beneath the dominion of the Zipas of Tunja and Bogotà and the Incas of Quito, and where the great mass of Indian population is still to be found, have a general medium temperature of 59°·37, modified however by local circumstances, and particularly by the proximity of the *Nevados*. Thus the village of Guaranda, placed at the base of Chimborazo, though nearly 500 feet less elevated, is at least one degree colder than the city of Quito, sheltered on all sides by the ramifications of Pichincha. The city again is above one degree warmer than its suburbs on the plains of Anaguito and Turupamba to the north and south. Riobamba is about two hundred feet below Quito; yet its situation on an open plain, bordered by the snowy mountains of Chimborazo, Tunguragua, and La Candelaria, renders the climate colder and more variable; while the town of Hambato, only 300 feet lower than Quito, but built in a nook of the river which runs near it, and shut in by dry, sandy elevations, has a climate about 2°·0 warmer; so that sugar-cane is cultivated in its immediate vicinity. The general uniformity of temperature, which spreads a certain monotony over tropical regions, is joined, at great elevations, to a daily variability which must

exercise a considerable influence both on vegetable and animal life. The thermometer, which often sinks at night to 44°, rises in the sun wherever there is a reflected heat, frequently to 120°, being equal to the heat of Jamaica; while in the shade, it seldom exceeds 65°; so that, on passing from shade to sunshine, one is immediately exposed to a difference of above 50°, and, in the course of twenty-four hours, to nearly 80°. The shade, in consequence, even on the hottest days, imparts a feeling of chilliness; while the solar rays seem to scorch like the vapor of a heated oven. The same difference is perceptible on the *paramos*. At the foot of the *Nevado* of Santa Marta I observed the thermometer at 5 a. m. sink to 22°; at 9 a. m. it rose to 73° in the sun. On the height of Pichan, betwixt Quito and Esmeraldas, elevation 12,986 feet, the thermometer stood at 53° in the shade, and 83° in the sun. On Antisana, the difference was 22° *at the same time*, but 34° betwixt 6 a. m. and 3 p. m. When the atmosphere is calm it is much more considerable.

5. Although at great elevations, i. e. from 12,000 to 16,000 feet, it is difficult to form a series of meteorological observations, such is the yearly equality of the temperature, that a single day may be safely taken as a sample of the whole year; nay, more, a collection of observations made at similar heights, though in different places, will give a similar result to a series taken on the same spot. Thus in the following table there is little difference betwixt the result of eight observations made on seven different mountains, and the six made on that of Antisana:

| | | | | | |
|---|---|---|---|---|---|
| 1. | Paramo of Santa Marta | 15,000 ft. | 22° | 5½ | A. M. |
| 2. | Paramo of Cayambe | 12,705 | 37°·6 | " | " |
| 3. | Paramo of El Altar | 12,986 | 42°·8 | " | " |
| 4. | Mine of Condorasto | 14,496 | 45°·0 | 12 | " |
| 5. | Volcano of Pichincha | 15,705 | 46°·0 | 1 | P. M. |
| 6. | Mountain of Atacaso | 14,820 | 41°·0 | " | " |
| 7. | Nevado of Cayambe | 14,217 | 43°·0 | 1½ | " |
| 8. | Paramo of Antisana | 14,520 | 38°·58 | 6 | " observations. |
| | General mean | | 39° | | |

Although it scarcely falls within the limits of a mere meteorological journal to expatiate on the wide field of inference which opens to our view, when we reflect on the influence of temperature, not merely on animal but on social life, yet the operation of local circumstances has been so striking, and will probably play so important a part in the future destinies of the South American continent, that it is difficult to forbear some remarks on so interesting a subject.

Climate is one of the first agents which operates upon the propagation of the human race over the face of the globe, presenting itself sometimes as a benignant conductor, at other times raising a hostile barrier which science and industry slowly overcome. The Spaniards who people that part of South America now under consideration, as soon as they had formed on the coast the establishments necessary to preserve their connection with the mother country, seem to have traversed hastily the fertile but insalubrious lowlands to meet on the Cordillera a temperature adapted to their habits and constitutions. The dominion of the Incas had, upon similar principles, extended itself along the immense ridge; and the descendants of the conquerors and conquered are, to this day, found united on the same elevations, from whence the population has descended gradually into the plains; and would have done so much more slowly, but for the importation of the African race, who find on the sandy coast and sultry savanna a climate congenial to their constitution. It may be a matter of curiosity to inquire, why that portion of the *bronzed race* which constituted the empire of the Incas and of the Lipas has constantly exhibited a constitutional type so different from the tribes of the same race now thinly scattered through the plains and valleys. The dominion of the Incas could scarcely be said to have established itself in the lowlands. With the exception of the dry narrow track of the Peruvian coast, their empire was exclusively of the mountains; and Indians who speak the *Quichua*, or general language of the Incas, still manifest the same preference for cold and elevated situations; sleeping in the open air rather than under a roof, and exhibiting an insurmountable repugnance to descend into the hot country, where they fall victims more rapidly than even the Europeans. The latter, although commercial interests have led them to form establishments on the coasts, and more partially on the great rivers, may be said to live in a state of perpetual hostility with the climate. Their complexions become sallow, their frames feeble; and although, where heat is uncombined with great moisture, as in Cumanà, Coro and Maracaybo, they are subject to few diseases of a violent character, the strength is gradually undermined, and the species may be rather said to vegetate than to increase. The individuals of African race, who complain of cold when the yearly mean is 75°, alone develope all the physical strength and energy of their character in the hot

lowlands of the coast and interior. The mixed race, or people of color, unite to bodily hardihood intrepidity, ambition, and a deadly feeling of those prejudices which, in spite of laws, continue to separate them from the *white* descendants of the Spaniards, who thus encounter, both in the high and lowland, two races in whom the seeds of hostility have been sown by injustice, and fostered by mistaken feelings of interest and vanity.* It is on the mountain slopes of from 3,000 to 7,000 feet that we encounter climates most analagous to our ideas both of health and pleasure. Raised above the noxious miasmata of the coast, we dwell in perpetual summer amid the richest vegetable productions of nature, amid a continued succession of fruits and flowers. This picture, however, must not be considered as universally exact. In those unbroken forests where population has made little progress, the sky is often clouded, and the soil deluged with continual rains. The western declivities of the Andes, which front the Pacific, are particularly exposed to this inconvenience.

It might be expected that with regard to human life and vigor, the elevated plains of the Andes would correspond to the northern countries of Europe. This, however, as far as regards the inhabitants of the European race, does not seem exactly to take place. It is true they escape the billious and intermittent fevers so prevalent in the lowlands; but they are generally subject to typhus, dropsy, goitre, and such complaints as indicate constitutional debility. Nor do we find among them either the muscular strength or longevity of the Indians or Africans; and still less of the nations of northern Europe. Are the diurnal changes of temperature to which they are exposed, less favorable to health than the alternation of European seasons which expose the frame to changes equally great but less rapid? Or must we rather look for the cause in their domestic habits, which exhibit a strange mixture of effeminacy and discomfort?

When we examine the social or political effects of climate and localities, we are struck with their powerful effects on the past struggles and present state of the country. The cities of the coast must be considered as the inlets both of European products and European ideas. Liberal opinions have extended themselves

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* It is the people of color, or mixture of Africans with Whites and Indians, who on the plains form the most hardy and warlike part of the population of Colombia.

towards the interior in proportion to local obstacles, i. e. to the greater or less facility of communication. It is this circumstance which marks the difference betwixt Venezuela and the south and the centre of Colombia, indicating a distinct and more rapid career of civilization and prosperity. The branch of the Andes which traverses Venezuela is much inferior in elevation to the ridges of Quito and New Grenada. The whole of the inhabited part of it belongs to the hot country or temperate mountain zone. The following are the heights of the principal towns through its whole extent:

| | | |
|---|---|---|
| Caraccas . . . | 2903 ft. | Mean temp. 71° |
| Valencia . . . | 1495 | ——— 78 |
| Barquisimeto . . | 485 | ——— 78 |
| Tocuyo . . . | 2058 | ——— 75 |
| Truxillo . . . | 2684 | ——— 75 |
| Merida . . . | 5280 | ——— 66 |
| Cucuta . . | about 400 | ——— 83 |

The differences of climate and productions betwixt the different parts of the country are consequently trifling, and form no bar to general communication betwixt the coast and interior. There is therefore an amalgamation of ideas, an homogeneity, if we may use the term, in the mass of feelings and opinions on political subjects. The population is not only more enlightened, but, what is of more importance, more equally so. A different state of things presents itself, when we examine the centre and south. The main ridge of the Andes ascends rapidly from the frontier of Venezuela, and, by its direction from north to south, places the population at a continually increasing distance from the sea-ports of the Atlantic; while its superior elevation producing a different climate and temperature, gives birth to new habits and a distinct nationality. To descend to the coast from these altitudes, is a matter both of risk and difficulty. The line betwixt the *Llaneros* and *Serranos* is strongly drawn, and a separation of character evident. The country from Cucuta to Bogotà through Pamplona and Tunja has a mean elevation of from 8,000 to 10,000 feet, and a temperature of about 59° Fahr. It is true that Bogotà communicates with Europe by the valley of the Magdalena; but the length and inconvenience of this channel of intercourse render it accessible but to few. Hence the struggle of opinions in New Grenada, where the civilization of the superior class is out of proportion to that of the bulk of the people.

The Quitean Andes afford us another powerful illustration of this view of the subject. The following is the line of elevations between Quito and Chimborazo:

| | | |
|---|---|---|
| Quito . . . . | 9,537 feet | 59° Fahr. |
| Llactacunga . . | 10,285 | 57° |
| Hambato . . . | | 61° |
| Riobamba . . | 9,377 | 57° |
| Guaranda . . . | 9,075 | 58° |

The roads which descend to the coast of the Pacific are few, almost impassible, and lead to no seaport of importance except Guayaquil. Journeys thither are undertaken with fear and hesitation; and the character of the *Serranos* is marked with all the traits of isolation resulting from the geography of the country.

Next to the direct influence exercised by climate on the frame of man, we may consider it relatively to the facility it affords of nourishing him, and advancing his progress in civilization. The most important presents made by the Old to the New World are cattle and cerealia. The only domesticated quadruped known to the Indians was the llama, which furnished, like the sheep, with thick wool, unwillingly descends or is propagated in the sultry lowlands. The horned cattle of Europe, on the contrary, have multiplied almost equally on the plains as on the *paramos*. On the farm of Antisana, for instance, at an elevation of from 12,000 to 16,000 feet, there is no less than 4,000 head. The herds raised on the plains of Venezuela, as on the *Pampas* of Buenos Ayres, are, or were previous to the revolution, almost countless. Two immense magazines of animal food are thus placed at the two extremes of temperature, in situations uninterfered with by agricultural labor. The horse has been destined to figure in the political changes of the New World. The fear and respect with which he inspired the natives at the period of the Conquest is well known. Horses have since multiplied prodigiously in all parts of the country, but more especially in the plains of Venezuela. There, during the war of independence, Paez, and other guerilla chiefs, at the head of an irregular cavalry, and maintained by the cattle, defied the efforts of the Spanish infantry, and kept alive the embers of the revolution.

The best kinds of horses are those that are bred in the lowlands, and brought to the mountains at about four years old, where they acquire hardihood by the influence of a colder climate, and their

hoofs, accustomed only to soft pastures, are hardened on a stony soil.

The breed of sheep, like that of llamas, is limited to the loftier regions of the Cordillera; while goats multiply more readily on such parts of the low country as are both hot and barren, as in the province of Coro, where they form the chief wealth of the inhabitants.

But while nature facilitates the dispersion over the globe of certain species of animals, she seems to limit others by an impassible barrier. The dog undergoes the fate of his European master; his sagacity and strength decay in a hot climate, and the breed dwindles rapidly into an animal totally inferior in habits and organization. The foresters accordingly, and the Indians of the lowlands, who are accustomed to the chase of the wild hog, bring dogs for the purpose from the mountains, where, though the Spaniards are by no means curious in this particular, a strong species of greyhound, more or less degenerated, is to be met with, and is used in the highlands for stag-hunting.

The influence of temperature, and consequently of local elevation, on vegetable life, was first examined in Colombia by a native of Bogotà, the unfortunate and illustrious D. Josè Caldas, who fell a victim to the barbarity of Murillo in 1811, in consequence of which his numerous researches in natural history were almost entirely lost, with the exception of some papers published in the *Seminario de Bogotà* in 1808, and fragments still existing in MS. or casually preserved and printed in Europe, to one of which I shall presently have occasion to refer. Humboldt travelled through South America about the same time that Caldas was directing the attention of his countrymen to physical science, and his investigations have fortunately been subjected to a less rigorous destiny. His admirable treatise, "*De distributione Plantarum geograph*ica," has left for future observers little but to corroborate the accuracy of his views and multiply facts in illustration of his theories.

When we begin our observations from the level of the sea, we find certain families of plants which scarcely ever rise to above 300 or 400 feet: the "*Sandalo*," producing the balsam of Tolu, the *Lecythis*, the *Coccoloba*, the *Bombax*, the *Rhizophora Mangle*, the *Manchineel*. A second and more numerous class push on to about 2,000 feet of elevation; such are the *Plinia*,

the "*Copàl*," the "*Anime*," the "Dragon's blood," the mahogany tree, the "*Guayacàn.*" Among plants, the *Cæsalpinia*, *Ipomæa quamoclet*, most of the *Bignonias*, *Portlandias*, the Vanilla, *Cassia alata* and *riparia*, the *Pontaderia*, which forms the ornament of tropical rivers. The palms ascend to the height of 5,000 feet; the arborescent ferns, from the level of the sea, amid the damp forest of Esmeraldas, to 7,000 feet. Of cultivated plants the Cacao and indigo are most limited as to elevation, neither of which is cultivated with success at above 2,000 feet. An attempt to raise indigo at Mindo (3,960 feet) completely failed. It would seem that a dry climate is most favorable to indigo, such as is found in the valleys of Aragua near Valencia; while heat and moisture, as Humboldt observes, are particularly required for cacao. Yet cacao cultivated on lands which are flooded part of the year, as is the case with the greater part raised in Guayaquil, is of inferior quality, scarcely producing in the market a dollar per cwt. That of Esmeraldas, on the contrary, where notwithstanding the moisture of the climate, the waters never settle on the soil, is of equal or superior quality to that of the valley of Tuy. near Caraccas. In Canigue, at an elevation of about 1,000 feet, the trees are loaded with fruit in less than two years from the time of sowing the seed; while generally three years is the period at which they are reckoned to commence bearing.

Coffee is abundantly raised from the level of the sea to elevations of 5,000 or 6,000 feet, or even higher in favorable situations. There are plantations near the valley of Banos in Quito at above 7,000 feet.

Cotton requires, according to Humboldt, a mean temperature of not less than 64°—60°, which would bring it to the elevation of Loxa.

The sugar cane is cultivated in Colombia from the level of the sea to an elevation, which may appear extraordinary, of 7,865 feet in the valley of Banos at the foot of Tunguragua, of 8,500 in the valley of Chillo below Quito, and of nearly 9,000 feet near the town of Hambato. It must be observed, however, with respect to the latter, that the *vegas* or nooks formed by the windings of the river, where alone it is raised, are so sheltered as to produce almost an artificial temperature. A palm tree brought young from Guayaquil flourishes there, and "*Aguacates*," (the fruit of *Laurus persea*) ripen perfectly, with oranges, limes, and other

fruits which in general are not cultivated at above 6,000 feet. In proportion, however, to the elevation is the time required for ripening the sugar-cane, varying from nine months at the elevation of 1,000 feet, to three years at the elevation above cited.

Plantains and maize are the principal articles of food in the lowlands or hot country, "*tierra caliente*," to use the expression of the natives. The larger variety of plantain, "*Plantano harton*," cannot be cultivated at elevations above 3,000 feet, while the smaller variety "*Camburi*," will ascend to 6,000 feet, maize is perhaps the plant which, of all others, embraces the greatest variety of temperature and elevation. It is cultivated with equal advantage from the level of the ocean to the flanks of the Andes, 0 to 11,000 feet; temperature 80°—59°. It is true, that in the lowlands it ripens in three months, whereas on the table lands of the Andes, it requires ten; but the grain is larger, and the ear fuller in the cold than in the hot country.

The central or temperate zone of the Andes is distinguished by the *Cinchonas*, the arborescent ferns which precede and accompany the palms nearly, and in the moist forests of the Pacific, entirely to the level of the sea.* At the back of the Pichincha they first appear about 8,500 feet. The *Alstræmerias* and *Calceolarias*, peculiar to the New World, belong to this zone, though the former ascend to 11,000 feet and the latter to 15,000.

The *Cerealia*, with almost all the varieties of European vegetables, belong to this region. Humboldt observes a peculiarity that wheat is grown near Vittoria at the elevation of 1,700 feet, and in Cuba near the level of the sea; (*Geo. Pl.*, p. 161) but it is probable that the reason why the cerealia are cultivated only at elevations where the *Musæ* disappear, may be the natural inclination of the inhabitants of the warm country to prefer the cultivation of a plant which yields an equal abundance of food with infinitely less labor, not only in the mere cultivation, but in the subsequent preparation. The three great wheat districts in Colombia are the mountain chain of Merida, the elevation of which rarely reaches 5,000 feet; with a general temperature of 72°; the plain of Pamplona, Tunja, and Bogotà, elevation 8,000 to 10,000 feet; temperature 58°; and the Quitenian Andes of the same height and temperature. Humboldt has accurately observed,

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* Humboldt, who had not visited these forests, confines them to betwixt 800 and 260 hexap. *De Geo. Pl.*, p. 185.

(*Geo. Pl.*, p. 152) that a comparison betwixt annual mean temperatures of Europe and the elevated tropical regions would by no means give a correct state of the climate. Thus, though the mean temperature of the south of France and of Quito be the same, (about 59°) such fruits as peaches, apricots, pears, figs and grapes, which ripen in perfection in the former, although abundantly produced in the latter, never attain their proper size or flavor. The reason is, that the temperature is equal throughout the year. There is consequently no period, as in Europe, of summer heat sufficient to ripen fruit requiring at this season a mean temperature of 65° or 70°. As far, however, as the height of 7,000 feet all kinds of fruit are cultivated with success; and the markets of the colder country are thus constantly supplied from the neighboring valleys or "*calientes.*" Humboldt is mistaken in supposing the olive always barren (*semper sterilis manet*, p. 154.) On the Quitenian Andes near Hambato, it produces abundantly, though little attention is paid to its cultivation.

When we ascend above the extreme limit of cultivation, which may be placed at 11,500 feet, and pass the region of the *Barnadesia*, *Hyperica*, *Thibaudiæ*, *Gaultheriæ*, *Buddleiæ*, and other coriaceous leaved shrubs which, at this elevation, form thickets of perpetual bloom and verdure, we enter the region of *Paramos* (13,000 to 15,000 feet) properly so called, which present to the eye unvaried deserts clothed with long grass, constituting the pasture grounds of the Andes. Humboldt is inclined to fix below this region the limit of forest trees; (*Geo. Pl.*, p. 148) and in fact very few are generally met with near this elevation on those flanks of the Cordillera which join the inhabited table lands. But I have observed on crossing the side of Pichincha, towards the uninhabited forests of Esmeraldas, that the forests occur nearly through the whole space which, on the eastern slope, is a naked *paramo*. Is this owing to a difference of climate? Or has the practice of burning the *paramos*, universal in the Andes, together with the demand for fire-wood in the vicinity of large towns, contributed to give this region the bare aspect it has at present? Further observations on the mountain slopes towards Maynas and Macas are necessary to throw light on this point. It is certain from the present aspect of the inhabited plain of Quito, where we meet with a few scattered trees of *Arayan* (*Myrtus*) and artificial plantations of *Capuli*, (*Prunus salicifolia*) we should con-

clude that the region of forests had scarcely ascended to the height of 8,000 feet, yet some of the houses of Quito are still standing, built with timber cut on the spot.

A circumstance which cannot have escaped the notice of those who have ascended towards the limit of perpetual snow, is the variety and luxuriance of the Flora at the very point where the powers of vegetation are on the brink of total suspension. At above 15,000 feet the ground is covered with *Gentianas*, purple, azure and scarlet; the *Drabas*, the *Alchemillas;* the *Culatium rufescens* with its woolly hood; the rich *Ranunculas Gusmanni;* the *Lupinus nanus* with its cones of blue flowers enveloped in white down; the *Sida Pichinchensis* spotting the ground with purple; the *Chuqueraga insignis;* all limited within a zone of about 500 feet, from whence they seem scarcely to be separated by any effort at artificial cultivation. Several attempts I have made to raise the Gentians, *Sida*, and other plants of the summits of the Andes, at the height of Quito, have been invariably unsuccessful. The attempts indeed to domesticate plants in a situation less elevated, is attended with greater difficulties than the transport of plants from one climate to another. Besides the difference of atmospheric pressure, as Humboldt has observed, plants transferred from one elevation to another never meet, for a single day, with the mean temperature to which they have been accustomed; whereas, transferred from one latitude to another, the difference is rather in its duration than in its intensity. It is easier to accustom a plant of the lowlands to this elevation, than to bring down those of the *paramos*. Thus the orange and lemon trees, Aguacates (*Laurus persea*) *Ricinus communis*, *Datura arborea*, all natives of the hot lowlands, grow and flourish, more or less at an elevation of 8,000 feet above the level of the sea.

### *On the Method of Measuring Heights by Boiling Water.*

It will be observed in the following Journal, that the indication of *heights* is, in most cases, joined with that of boiling water. The former is in fact a deduction from the latter; I had but a confused idea of this method, till, upon my arrival at Quito, I met with a pamphlet of the late D. Francisco José Caldas, (one of the most eminent victims sacrificed by the barbarity of Murillo on taking possession of Bogotà in 1816,) published in 1819 at Bourdeaux, in which he details the steps by which he arrived

at a knowledge of this principle, and the experiments by which he confirmed it. In the year 1801, during a scientific excursion in the neighborhood of Popayan, he happened to break his thermometer; and in attempting to mend it he was led to observe the variability of the extremity of the scale corresponding to the heat of boiling water. His reflections on this subject led him, after various experiments, to the following conclusions: "The heat of boiling water is in proportion to the atmospherical pressure: the atmospherical pressure is in proportion to the height above the level of the sea; the atmospherical pressure follows the same law as the risings of the barometer, or, properly speaking, the barometer shows nothing more than the atmospherical pressure. Boiling water therefore shows it in the same manner as the barometer. It can consequently show the elevation of places in the same manner, and as exactly as this instrument." *Ensayo de una memoria sobre un nuevo metodo de medir las montañas, etc.* p. 10. His first experiment in Popayan gave b. w. 75°.7 of Reaumur, the height of the barometer being 22 in. 11 l. To find then the variation corresponding to one inch of the barometer:

$$28^{in}. - 22^{in}.\ 11^{l}. = 5°.1 \text{ or } 61 \text{ lines.}$$

$$80° - 75°.7 = 4°.3. \quad \text{Then}$$

$$61^{l}. : 4°.3 :: 12^{l}. : \frac{4°.3 \times 12}{61} = 0°.8.$$

Then reversing the process

$$0°.8 : 12^{l}. :: 4°.3 : \frac{4°.3 \times 12}{0°.8} = 64.5 = 5^{i}.4\tfrac{1}{2}$$

Difference betwixt this result and that of the barometer $3\frac{1}{2}$ lines. Satisfied with this commencement, or dawning of a new theory, he began a series of experiments in the mountains near Popayan, taking this city as the centre of his labors, and fixing the elevation of the barometer at $22^{i}.\ 11^{l}.\ 2$, and boiling water at 75°.65 of Reaumur.

At a spot named Las Juntas I made my first observation. The barometer stood at $21^{i}\ 9^{l}$, or $14^{l}$ lower than at Popayan; the heat of boiling water was 74°.5 Reaumur. Then

| | | | |
|---|---|---|---|
| Height of the barometer in Popayan | $22^{i}$ | 11.2 B. W. | 75°.65 |
| at Las Juntas | 21 | 9 ——— | 74°.50 |
| | 1 | 2.2 | 1°.15 |

$1\ 2.2 = 14^{l}.2 : 1°.15 :: 12^{l} \frac{12 \times 1°.15}{14.2} = 0°.971$ of Reaumur for $12^{l}$. of the barometer.

I ascended to Paisbamba, a small farm five leagues south of Popayan. Barometer $20^{i}\ 9^{l}.1$. B. W. 73°.5.

| | | | |
|---|---|---|---|
| Barometer in Popayan | $22^{i}$ | $11^{l}.2$ | B. W. 75°.65 |
| in Paisbamba | 20 | 9.1 | B. W. 73 .50 |
| Differences | 2 | 2.1 | 2° 15 |

$2\ 2.1 = 26^{l}.1 : 2°.15 :: 12 \frac{12 \times 2.15}{26.1} = 0°.988$ of Reaumur, for 12 lines of the barometer.

I ascended a hill E. of Paisbamba called Sombreros. Barometer $19^{i}.\ 6^{l}.5$. B. W. 72°.4.

| | | | |
|---|---|---|---|
| Barometer in Popayan | $22^{i}$ | $11^{l}.20$. | B. W. 75°.65 |
| on Sombreros | 19 | 9.05. | B. W. 72 .40 |
| Differences | 3 | 5.15. | 3 .25 |

$41^{l}.15 : 3°.25 :: \frac{12 \times 3°.25}{41.15} = 0.947$ for 12 lines barometer.

I ascended the hill of Tambores: barometer $18^{i}\ 11^{l}.6$. B. W. 71°.75.

| | | | |
|---|---|---|---|
| Barometer in Popayan | $22^{i}$ | $11^{l}.2$. | B. W. 75°.65 |
| on Tambores | 18 | 11.6. | B. W. 71 .75 |
| Differences | 3 | 11 .6. | 3 .90 |

$47^{l}.6 : 3°.9 :: 12 \frac{12 \times 3.9}{47.6} = 0.983$ for $12^{l}$ barometer.

Proof that above $\frac{9°}{10}$ of Reaumur is the true exponent of one inch of the barometer.

I then proceeded to take the observations of Las Juntas and Sombreros, and calculating the exponent anew.

| | | | |
|---|---|---|---|
| Barometer in Las Juntas | 21 | 9 | B. W. 74.60 |
| in Sombreros | 19 | 6.05 | 72.40 |
| Differences | 2 | 2.95 | 2.2 |

$26.95 : 2°.2 :: 12 \frac{12 \times 2.2}{26.95} = 0°.979$ Reaumur for 12 lines of the barometer.

| | | | | |
|---|---|---|---|---|
| Barometer in Paisbamba | 20 | 9.1. | B. W. | 73°.50 |
| in Tambores | 18 | 11.6. | | 71 .75 |
| Differences | 1 | 9.5 | | 1°.75 |

$1.9.5 = 21^{l}.5 : 1°.75 :: 12 \frac{12 \times 1°.7}{21.5} = 0°.976$ of Reaumur for 12 lines of barometer.

The mean of the six quotients is 0.974, which may be assumed as the exact exponent of 12 lines of the barometer.

*Given then the heat of boiling water in any place to find the corresponding elevation of the barometer, and consequently its height above the sea.*

As 0°.974 : 12 lines, so is the difference of the heat of B. W. To ascertain at Popayan the number of inches, lines, &c. of the barometer. Ex. in Tambores, B. W. 71°.15, to find the corresponding height of the barometer.

| | | |
|---|---|---|
| B. W. in Popayan | 75°.65 | |
| in Tambores | 71 .75 | |
| | 3 .90 | |

$0.974 : 12 :: \frac{3.9 \times 12}{974} = 48^{l}.05 = 4.0.05.$

As Tambores is above Popayan, deduct this quantity from the height of the barometer in that city.

| | | |
|---|---|---|
| Barometer in Popayan | 22 | 11.20 |
| Deduct | 4 | 00.05 |
| Remain | 18 | 11.15 ht. of bar. in Tambores. |
| Barometrical height observed | 18 | 11.60 |
| Do. by calculation of B. W. | 18 | 11.15 |
| Difference | | 45 |

a result as exact as can be desired.

Upon this principle I calculated the elevation of the following eleven places:

| | |
|---|---|
| Popayan, | Poblason, |
| Juntas, | Buenavista, |
| Paisbamba, | Hevradura, |
| Sombreros, | Pasto, |
| Tambores, | Quito. |
| Estrellas, | *Memoria, &c.* p. 13. *et seq.* |

Working upon the foregoing principle, Caldas adapted to his thermometer a barometrical scale. The product of 0°.974 of Reaumur by 19 is 18.506, or, in round numbers 18.5, i. e. 18°.5 of Reaumur corresponds to 19 inches of the barometer. Then measuring 18.5 from the summit, or 80° of Reaumur's scale, he transferred it to the opposite side of the thermometer, dividing it into 19 equal parts, or inches of the barometer, subdividing these by a nonius into 24 each = half a line of the barometer. In this manner the elevation of the thermometer by boiling water indicates the corresponding elevation of the barometer under the same atmospheric pressure. Caldas observes that Humboldt, to whom he had communicated these ideas, when they met in Popayan, objected the variability of the heat of boiling water under the same atmospherical pressure; to which he replies: "Long practice has taught me its invariability in this respect, using the requisite precautions in making the experiment: otherwise, how could there be equal thermometers? Is not the invariability of the heat of boiling water under the pressure of twenty-eight inches, the foundation of the superior term of all thermometrical scales? It is true that boiling water does not *immediately* acquire its extreme heat, but pushing the operation to its *maximum* its heat is always the same." p. 24.

Caldas did not consider an invariable exponent possible, on account of the variability of atmospheric pressure. The want, however, of a barometer induced me to make some experiments to this effect, by way of rendering this method of measuring elevations still more simple, and of more general use. Is the variability of atmospheric pressure such as to make any important difference in these calculations? Does not water boil constantly at 212° at the level of the sea? At Quito I found the same result as Caldas had several years before; and several times the same result in this and other parts of the Andes. The difference then, is scarcely perceptible in the thermometer, and consequently unimportant in the results of a calculation founded on the heat of boiling water. The thermometer besides, immersed in boiling water, is less liable to a variety of atmospheric influences to which the mercury of the barometer is necessarily subject. Hence the great differences in different barometrical measurements of the same elevations, and the differences observed betwixt different thermometers exposed to the air in the same place,

which I have observed on comparing three together to amount often to $1\frac{1}{2}°$, and never to less than $\frac{1}{2}°$.

I took the following method to obtain an exponent of the value in feet of each degree of the diminished temperature of boiling water.

The elevation of Quito is, according to Boussingault, 9524; and water boils at 196°.25; $212° - 196°.25 = 15°.5.9524 \div 15.75 = 604$ ft. 6. in. nearly. Neglecting the fraction as unimportant, I assumed 604 for the value of the degree, and began my observation on the conical hill of Javirac, which backs the city, and is calculated at 729 feet in height. Water boiled here by two thermometers at 195°. Then $196°.25 \div 195 = 1.25$, difference of boiling water between the hill and the city; and $1.25 \times 604 = 755$ feet; difference 26 feet. I next ascended the volcano of Pichincha, and found at the foot of the crater B. W. $186°.212° - 186° = 26° \times 604 = 15{,}730$ feet; and adding 246 feet, the difference between this point and the summit, reckoned at 15,976. There could be little error in the calculation. I next applied this formula to the heights of several places calculated by Humboldt, and where the heat of boiling water had been ascertained by Caldas.

| | | |
|---|---|---|
| Thus Bogotà, height according to Humboldt | - | 8694 ft. |
| B. W. according to Caldas 197°.6 | - - - | 8712 |
| Difference | - - - | 18 |
| Popayan, according to Humboldt | - - - | 5823 |
| B. W. 202°.21 | - - - - - - | 5922 |
| Difference | - - - | 99 |
| Pasto, according to Humboldt | - - - | 8572 |
| B. W. 197°.6 | - - - - - - | 8712 |
| Difference | - - - | 140 ft. |

The differences here are in four points 27 feet, 18, 99, 140. With respect to the hill of Javirac, commonly called *El Panecillo*, I suppose the measurement to have been made by the Academicians. But their calculations generally differ from those of Humboldt, as in the case of Quito; the former giving 9371 feet, the latter 9537; Pichincha 15,606 feet, Humboldt 15,976; Chimborazo 20,583, Humboldt 21,414. But even a difference of sites

is sufficient to account for the 27 feet on ground so unequal as that of Quito. The 18 feet in the height of Bogotà is so trifling a difference, that it rather proves the exactness of my calculation. In Popayan we have 99 feet; yet the different barometrical measurements of that city differ still more widely. Caldas observes, p. 31, "The Baron de Humboldt's barometer stood in Popayan at 23 3.4, mine at 22 11.2, and Bouguer's at 22 10.7." The most accurate measurements of the peak of Teneriffe, selecting 4 out of 14, leaves a difference of 71 French toises, or rejecting the barometric measurements of Borda, of 18 toises.—*Humboldt, Pers. Nar.* v. 1, p. 160, 170. Saussure is said to have found water boil at 187° on the summit of Mont Blanc, being, according to Humboldt, 15,660 ft. It is 90 ft. only below the point on Pichincha, where I found it to boil at 186°. The elevations nearly equal the difference cannot amount to a degree; and I consider the error less likely to be on my side, because I was aware of the probable cause of error, and had to deduce the height from the accuracy of the observation. Humboldt in the same manner suspects the accuracy of Lamouroux's observation on the peak of Teneriffe.—*P. Nar.* vol. i. p. 159.

[To be continued.]

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Art. II.—*Remarks on the Trilobite;* by Jacob Green, M. D., Professor of Chemistry in the Jefferson Medical College, Philadelphia.

*Remarks.*—We are informed by the author that the present communication was written originally for this Journal; but some peculiar circumstances induced him to publish it (March 16, 1839) in the Friend, a weekly Journal of Philadelphia. By the author's request it is now republished with additions.—*Eds.*

The anatomical structure and physiological history of the whole family of the trilobites are not only involved in great obscurity, but we can scarcely hope that the most persevering efforts of the naturalist will ever be able to penetrate the darkness, or unravel the mysteries, which involve the subject. No department in the science of organic remains has been pursued of late with more zeal and curiosity than this. The trilobite furnishes

the earliest example of an articulated animal found among the ancient inhabitants of our globe, and although in some few existing genera we find certain points of analogy in their organization, the whole race probably became extinct after the subsidence of the great coal formation. Dr. Buckland remarks, "No trilobites have yet been found in any strata more recent than the carboniferous series; and no other crustaceans, except three forms which are also entomostracous, have been noticed in strata coeval with any of those that contain the remains of trilobites; so that during the long periods that intervened between the deposition of the earliest fossilliferous strata and the termination of the coal formation, the trilobites appear to have been the chief representatives of a class which was largely multiplied into other orders and families after these earliest forms became extinct."

From the multitude of trilobites and fragments of trilobites which have been discovered in different parts of the world, most of which present nothing but portions of the upper shell of the fossil, the discovery of the figure of the under side of the animal, and of the form and arrangement of the organs of locomotion, seems almost hopeless. As the solid parts of the animal structure alone are for the most part susceptible of petrifaction, it is not to be expected the softer portions would leave any traces whatever in the rocks which have entombed and so perfectly preserved these ancient inhabitants of our planet; for these reasons, and some others which we shall presently mention, the legs of the trilobite have been supposed to be soft and very perishable paddles.

Although much controversy formerly existed as to the true nature of the trilobite, it is now admitted by all naturalists to occupy a place among crustaceous animals. The existing genera to which they are most analogous in their general structure are the serolis, the limulus, and the branchipus. In our monograph we announced the discovery of a recent trilobite in the southern seas, near the Falkland islands: this proves to be a species of the genus serolis established by Dr. Leach. In the configuration of its upper shell it approaches exceedingly near to that of some of the trilobites; the chief difference between the recent and fossil animal consists in the crustaceous legs and antennæ of the serolis. The analogies existing between the limulus and our fossil, as we mentioned in another place, have been shown by Dr. Dekay and others.

In further illustration of this subject, we here add, with some slight alterations, from Dr. Buckland's admirable Bridgewater treatise, a considerable part of his section on the trilobites, which exhibits in a very condensed form the facts and opinions which have any bearing on this inquiry. I have greater satisfaction and more confidence in referring to his remarks, than in attempting to offer any thing of a similar nature drawn up by myself. After mentioning that the serolis is the nearest approach among living animals to the external form of trilobites, he adds, the next "approximation to the character of trilobites occurs in the limulus or king crab,* a genus now most abundant in the seas of warm climates, chiefly in those of India, and of the coasts of America. The history of this genus is important, on account of its relation both to the existing and extinct forms of crustaceans; in it there are but slight traces of antennæ, and the shield which covers the anterior portion of the body, is expanded entirely over a series of crustaceous legs. Beneath the second, or abdominal portion of the shell, is placed a series of thin, horny, transverse plates, supporting the fibres of the branchiæ, and at the same time acting as paddles for swimming. The same disposition of laminated branchiæ is found also in the serolis. Thus while the serolis presents a union of antennæ and crustaceous legs, with soft paddles bearing the branchiæ, we have in the limulus a similar disposition of legs and paddles, and only slight traces of antennæ; in the branchipus we find antennæ, but no crustaceous legs; while the trilobite being without antennæ and having all its legs represented by soft paddles, is by the latter condition placed near branchipus

* In my boyhood I was very familiar with the habits of this crustacean, called in the northern States, horse fish—or horse shoe fish, from its form.

On the fine hard sea beach at Fairfield in Connecticut, I was in the habit of taking these animals in great numbers, for the purpose of feeding ducks: the ova being very abundant, and being greedily devoured by the young ducks, after the shell of the animal is crushed or cut open. Their fecundity must have been very great, since a large individual female, (the horizontal diameter of whose shell might have been nine or ten inches,) afforded several gills of spawn. The habit of these animals is to come in with the rising tide, and to walk on the bottom, ascending the shelving beach, until they arrive in shallow water. The pellucid sea at Fairfield, rippling over siliceous sand, enabled me and my puerile companions to see them through the waves, and by wading we easily secured them by seizing the spike or tail, their motion being too slow to admit of their escape. Hundreds of them might have been caught at a single tide, of every size from nearly a foot in diameter to an inch or less—these infants having also the power of travelling on the bottom.—Sen. Ed.

among the entomostracous crustaceans, in the order of branchiopods, whose feet are represented by ciliated paddles, combining the functions of respiration and natation.

"In the comparison here made between four different families of crustaceans, for the purpose of illustrating the history of the long extinct trilobites, by the analogies we find in the serolis, limulus, and branchipus; we have a beautiful example, taken from the extreme points of time of which geology takes cognizance, of that systematic and uniform arrangement of the animal kingdom, under which every family is nearly connected with adjacent and cognate families. Three of the families under consideration are among the present inhabitants of the water, while the fourth has been long extinct, and occurs only in a fossil state. When we see the most ancient trilobites thus placed in immediate contact with our living crustaceans, we cannot but recognise them as forming part and parcel of one great system of creation, connected through its whole extent by perfect unity of design, and sustained in its minutest parts by uninterrupted harmonies of organization.

"We have in the trilobites an example of that peculiar, and, as it is sometimes called, rudimentary development of the organs of locomotion in the class crustaceans, whereby the legs are made subservient to the double functions of paddles and lungs. The advocate for the theory of the derivation of existing more perfect species, by successive changes from more simple ancient forms, might imagine that he sees in the trilobite the extinct parent stock, from which, by a series of developments, consecutive forms of more perfect crustaceans may, during the lapse of ages, have been derived; but according to this hypothesis, we ought no longer to find the same simple condition as that of the trilobite still retained in the living branchipus, nor should the primeval form of limulus have possessed such an intermediate character, or have remained unadvanced in the scale of organization, from its first appearance in the carboniferous series, through the midway periods of the secondary formations, unto the present hour.

"Besides the above analogies between the trilobites and certain forms of living crustaceans, there remains a still more important point of resemblance in the structure of their eyes. This point deserves peculiar consideration, as it affords the most ancient, and almost the only example yet found in the fossil world, of the preservation of parts so delicate as the visual organs of animals that

ceased to live many thousands, and perhaps millions of years ago. We must regard these organs with feelings of no ordinary kind, when we recollect that we have before us the identical instruments of vision, through which the light of heaven was admitted to the sensorium of some of the first created inhabitants of our planets.

"The discovery of such instruments in so perfect a state of preservation, after having been buried for incalculable ages in the early strata of the transition formation, is one of the most marvellous facts yet disclosed by geological researches; and the structure of these eyes supplies an argument, of high importance in connecting together the extreme points of the animal creation. An identity of mechanical arrangements, adapted to the construction of an optical instrument, precisely similar to that which forms the eyes of existing insects and crustaceans, affords an example of agreement that seems utterly inexplicable without reference to the exercise of one and the same Intelligent Creative Power.

"Professor Müller and Mr. Straus have ably and amply illustrated the arrangements, by which the eyes of insects and crustaceans are adapted to produce distinct vision, through the medium of a number of minute facets, or lenses, placed at the extremity of an equal number of conical tubes, or microscopes; these amount sometimes, as in the butterfly, to the number of 35,000 facets in the two eyes, and in the dragon-fly to 14,000.

"It appears that in eyes constructed on this principle, the image will be more distinct in proportion as the cones in a given portion of the eye are more numerous and long; that, as compound eyes see only those objects which present themselves in the axes of the individual cones, the limit of their field of vision is greater or smaller as the exterior of the eye is more or less hemispherical.

"If we examine the eyes of trilobites with a view to their principles of construction, we find both in their form, and in the disposition of the facets, obvious examples of optical adaptation.

"In the asaphus caudatus each eye contains at least 400 nearly spherical lenses fixed in separate compartments on the surface of the cornea. The form of the general cornea is peculiarly adapted to the uses of an animal destined to live at the bottom of the water: to look downwards was as much impossible as it was unnecessary to a creature living at the bottom; but for horizontal vis-

ion in every direction the contrivance is complete. The form of each eye is nearly that of the frustrum of a cone, incomplete on that side only which is directly opposite to the corresponding side of the other eye, and in which, if facets were present, their chief range would be towards each other across the head, where no vision was required. The exterior of each eye, like a circular bastion, ranges nearly round three fourths of a circle, each commanding so much of the horizon, that where the distinct vision of one eye ceases, that of the other eye begins, so that in the horizontal direction the combined range of both eyes was panoramic.

"If we compare this disposition of the eyes with that in the three cognate crustaceans,* by which we have been illustrating the general structure of the trilobites, we shall find the same mechanism pervading them all, modified by peculiar adaptations to the state and habits of each; thus in the branchipus, which moves with rapidity in all directions through the water, and requires universal vision, each eye is nearly hemispherical, and placed on a peduncle, by which it is projected to the distance requisite to effect this purpose.

"In the serolis, the disposition of the eye, and its range of vision, are similar to those in the trilobite, but the summit of the eye is less elevated; as the flat back of this animal presents little obstruction to the rays of light from surrounding objects.

"In the limulus, where the side eyes are sessile, and do not command the space immediately before the head, two other simple eyes are fixed in front, compensating for the want of range in the compound eyes over objects in that direction.

"In the above comparison of the eyes of trilobites, with those of the limulus, serolis, and branchipus, we have placed side by side, examples of the construction of that most delicate and complex organ, the eye, selected from each extreme, and from a midway place in the progressive series of animal creations. We find in trilobites of the transition rocks, which were among the most ancient forms of animal life, the same modifications of this organ which are at the present time adapted to similar functions in the living serolis. The same kind of instrument was also employed in those middle periods of geological chronology, when the secondary strata were deposited at the bottom of a warm sea,

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* See annexed the plates of Dr. Buckland, which being important to the just comprehension of the subject, we have caused to be copied.—Eds.

inhabited by limuli, in the regions of Europe, which now form the elevated plains of central Germany.

"The results arising from these facts, are not confined to animal physiology; they give information also regarding the condition of the ancient sea and ancient atmosphere, and the relations of both these media to light, at that remote period when the earliest marine animals were furnished with instruments of vision, in which the minute optical adaptations were the same that impart the perception of light to crustaceans now living at the bottom of the sea.

"With respect to the waters wherein the trilobites maintained their existence throughout the entire period of the transition formation, we conclude that they could not have been that imaginary turbid and compound chaotic fluid, from the precipitates of which some geologists have supposed that the materials of the surface of the earth to be derived; because the structure of the eyes of these animals is such, that any kind of fluid in which they could have been efficient at the bottom, must have been pure and transparent enough to allow the passage of light to organs of vision, the nature of which is so fully disclosed by the state of perfection in which they are preserved.

"With regard to the atmosphere also we infer, that had it differed materially from its actual condition, it might have so far affected the rays of light, that a corresponding difference from the eyes of existing crustaceans would have been found in the organs on which the impressions of such rays were then received.

"Regarding light itself also, we learn from the resemblance of these most ancient organizations to existing eyes, that the mutual relations of light to the eye, and of the eye to light, were the same at the time when crustaceans endowed with the faculty of vision were first placed at the bottom of the primeval seas, as at the present moment.

"Thus we find among the earliest organic remains, an optical instrument of most curious construction, adapted to produce vision of a peculiar kind, in the then existing representatives of one great class in the articulated division of the animal kingdom. We do not find this instrument passing onwards, as it were, through a series of experimental changes, from more simple into more complex forms; it was created at the very first, in the full-

ness of perfect adaptation to the uses and condition of the class of creatures, to which this kind of eye has ever been, and is still appropriate.

"If we should discover a microscope, or telescope, in the hand of an Egyptian mummy, or beneath the ruins of Herculaneum, it would be impossible to deny that a knowledge of the principles of optics existed in the mind by which such an instrument has been contrived. The same inference follows, but with cumulative force, when we see nearly four hundred microscopic lenses set side by side, in the compound eye of a fossil trilobite; and the weight of the argument is multiplied a thousand fold, when we look to the infinite variety of adaptations by which similar instruments have been modified, through endless genera and species, from the long lost trilobites, of the transition strata, through the extinct crustaceans of the secondary and tertiary formations, and thence onward throughout existing crustaceans, and the countless hosts of living insects.

"It appears impossible to resist the conclusions as to unity of design in a common Author, which are thus attested by such cumulative evidences of Creative Intelligence and Power; both, as infinitely surpassing the most exalted faculties of the human mind, as the mechanisms of the natural world, when magnified by the highest microscopes, are found to transcend the most perfect productions of human art."

We now proceed to the more immediate object of this communication, which is to describe a portion of the under side of the fossil animal, which we have named in our monograph calymene bufo.

Some time since, my attention was directed by Dr. J. J. Cohen, of Baltimore, to a number of fragments of the heads of this species, obtained from the vicinity of Berkley, Va., and which are still preserved in his cabinet. Three or four of these fragments seemed to disclose the configuration of the whole lower surface of the buckler, in a more or less perfect state. Within a few months, another friend brought for my examination, a fine large head of the same species, from the same locality, and which exhibited the under side or thorax, in quite a perfect state of preservation. All the fragments have precisely the same structure, so that there can be no doubt, we have now the external configuration of the entire head or buckler of the calymene bufo.

The anterior edge of the buckler of this species, as has been often observed, is marked by a deep groove or furrow, produced apparently by the junction of the upper and the under shell at this place, and which at first sight looks like the *mouth* of the animal; indeed, Professor Brongniart calls the elevated ridges on each side of this groove the *lips*. The *mouth* was, however, placed no doubt much farther beneath. These *lips*, perhaps, indicate the separation of the shell, through which the trilobite crept out, and left his cast-off covering in the same manner as recent crustaceans leave their exuviæ. We know that the *limulus polyphemus* creeps through a somewhat similar opening, made along the whole anterior edge of his buckler.* In all our fragments, which exhibit the under surface of the buckler, the lower *lip* is reflected beneath, so as to form a kind of scroll or rolled edge, extending from one side or angle of the head to the other. Beneath this, and passing backwards towards the tail, the surface of the shell is not flat and horizontal as in the *isotelus* and *limulus;* but it swells up on each side, below the oculiferous prominences, into a kind of oval pouch, diminishing in breadth as it recedes, and at last terminates in a rounded point, below the second articulation of the vertebral column. This is the position of the gullar pouch or plate, when the animal assumes a creeping or swimming attitude: but when rolled up in the form of a ball, for the purpose of defence, then the gullar plate being composed of a single piece, and therefore not contractile, reached below the fourth articulation of the back. Some of our specimens illustrate this conformation in a very satisfactory manner. None of our fragments exhibit fairly the small surface on each side of the gullar plate, and the edge of the buckler beneath the eyes. This space was probably slightly concave, and occupied with the mandibles and their palpi, as in the genus serolis—the mouth being no doubt placed near the rounded termination of the gullar pouch.

Thus we have at last discovered nearly the whole inferior surface of the buckler of the genus calymene, a portion which includes about one third of the animal. Not the slightest impression or other vestige of antennæ can be perceived, and we may therefore pretty confidently conclude, that this genus of trilobites were destitute of those organs. Professor Demarest, in his his-

* See Dr. Dekay. Annals of Natural History, vol. 1.

tory of fossil crustacea, seems to have ascertained by his useful and ingenious researches, that the irregularities of the external shells in the living species of crustaceans have a constant relation to distinct compartments in their internal organization, and by the application of these distinctions to fossil species, he has been enabled to draw some highly curious, novel, and important conclusions respecting their internal and general structure. From my limited knowledge of the anatomy and the habits of our living crabs, I would merely suggest, that the peculiar organ in the animal economy of the trilobite, which the gullar plate above described, was intended to model and protect, was perhaps the *stomach*, and that the spaces on each side covered the anterior portions of the *liver*.

The upper shell of the genus calymene, like that of the isotelus and depleuva, naturally and obviously divides itself into three parts, the buckler or shield—the abdomen and the caudal end. This last portion in the calymene is not covered with a thick epidermis, as in the two genera above mentioned, the articulations being all visible and somewhat difficult, in some species, to distinguish from those of the abdomen. These articulations, which are generally ten in number, are composed of a variety of immovable plates as in the other genera. The inferior surface of the caudal end of the trilobite had never been observed by any naturalist, till my friend Dr. Cohen, obtained some fragments of the genus calymene from the neighborhood of Berkley Springs, in Virginia, in some of which that structure was developed. These were kindly sent to me for examination, along with those of the buckler just described.

From our researches we have ascertained, that the inflexible margin which surrounds the caudal end or tail of the calymene bufo, is not reflected beneath the body of the animal, as might be expected, but that there is joined to it by a structure a slightly concave horizontal surface. This surface is lunate, being broader below the articulations of the vertebral column, gradually diminishing on each side towards the horns of the crescent, which terminates just below the last articulations of the abdomen. This lunate surface is composed of a thick crustaceous plate or piece. Beyond this crescent shaped piece, directly below the vertebral column, there is a deep cavity in the under shell of the animal, which corresponds in figure and dimensions with the gullar pouch

or under surface of the buckler. By this peculiar mechanism, whenever the animal rolled itself into a ball, to give protection to the soft parts of the abdomen, the protuberance under the shield would be introduced into the cavity below the tail, and thus retain the whole shell in a fixed position. In this position, with the tail closed upon the buckler, the calymene is often found.

Professor Wahlenberg considers those trilobites only as perfect animals, which are found rolled, the others being merely exuded or cast-off shells, and in such alone, he remarks, can we expect to discover the organization of the inferior surface. Most of the fragments from Berkley Springs, which have occasioned my present remarks, are found rolled up or partially coiled animals. All trilobites have not, however, this power; indeed, it seems to be principally confined to those only whose extremities are rounded and nearly equal in size. The rolled position would afford to the paradoxides and to many of the asaphs, but little security against the attacks of their enemies, and we rarely if ever find them in this attitude. The remark of Professor Wahlenberg above cited, though illustrated by the specimens now under consideration, we think of far too general a nature.

The deep cavity beneath the tail in the fragments which we are describing, reaches forward towards the head as far as the ninth articulation of the back; in other words, a portion of it lies beneath the three last abdominal divisions. It will be recollected that the gullar pouch reaches below the fourth articulation of the back, and that the whole number of divisions in the vertebral column in the genus calymene, is twelve; we have therefore discovered in these fragments almost the whole of the inferior surface, except the portion which lies below the five articulations of the back commencing with the fifth from the buckler or shield; what we shall offer in regard to this portion of the animal must be merely hypothetical, or founded on certain analogies of structure which probably existed between living crustaceous animals and the fossil remains of such as inhabited the most ancient seas.

Some of our fragments, we think, exhibit a transverse section of our trilobite, showing the position and figure of the abdominal cavity which once contained a portion of the viscera of the animal. One of the sections is through and parallel with the sixth articulation of the back: by this means we have discovered that

some of the viscera were placed in a cylindrical cavity running beneath the vertebral column, and that the side lobes were only a covering and protection to the soft paddles or feet placed below, as may be seen in a similar structure in the serolis. Each of the five articulations of the abdomen, the under side of which we have not yet discovered, was probably furnished below, on each side of the abdominal cavity, with organs, which performed the double office of feet and lungs. Now, as our fragments develope all the inferior surface except the portion beneath these five articulations of the abdomen, it is probable that our trilobite was a *decapodous animal.* Professor Brongniart long ago imagined, that the reason why no traces of these organs have yet been discovered, is that the trilobites held that place among crustaceous animals in which the antennæ disappear, and the legs become transformed into soft paddles incapable of preservation. If this supposition be true, we shall in vain look for any further discoveries below the upper shell of the trilobite. What affords, we think, increasing probability to the opinion we have just advanced with regard to the situation of the abdominal cavity, and the organs of locomotion below the five abdominal arches above mentioned, is, that when the animal rolled itself up for protection, this portion of the body would still retain nearly a rectilinear position ; thus no interference would occur in the ordinary functions of the animal economy when the body was contracted.

Besides the organs of locomotion and respiration beneath the abdominal arches of the genus calymene, it is probable that on each side of the deep cavity under the caudal end there was placed a series of thin transverse plates, which also performed the combined functions of breathing and swimming : a similar disposition of laminated branchiæ may be observed also in the limulus and in the serolis. Beneath this deep cavity the heart of the animal was also probably placed.

What we have said with regard to the inferior mechanism of the trilobite, applies exclusively to the genus calymene. It is probable that this structure differs essentially in all the genera of this remarkable family. Dr. Dekay has described and figured in the first volume of the *Annals of the Lyceum of Natural History of New York*, the under side of the buckler of the isotelus, which is very peculiar in its configuration ; he describes this inferior surface as being formed by the anterior part of the buckler

being reflected beneath the animal so as to form a flat horizontal plane, which terminates in a kind of lunate spine, the horns of the crescent being curved towards each other. These horns are six lines in length, and their points are sharp and translucent. We have received from Dr. Warder a specimen of this singular structure, which was found, with other fragments of the isotelus, near Springfield in Ohio. Although it lies on the rock, unaccompanied by any other fragment of the animal, its exact resemblance to the figure given by Dr. Dekay leaves no doubt that it once belonged to an isotelus. Among other conjectures respecting the uses of this crescent-shaped structure, it is observed that when the animal was attacked "it may roll itself up into a ball, as indeed it is often found, and by some mechanism these processes may be inserted into the corresponding cavities in the tail, and thus retain permanently a rolled position, presenting nothing but its calcareous covering to the enemy; or they may supply the place of antennæ, for which their form and contiguity to the mouth and brain would seem to render them peculiarly applicable." The first conjecture above noticed was ingenious, and will no doubt be confirmed when the lower surface of the tail is discovered. The inferior organization of the calymene bufo has at any rate given great plausibility to this opinion.

We have also carefully examined another fragment representing a similar structure. The original fossil was found in Ohio, and is now in the possession of W. Wagner, Esq. of Philadelphia. The rock on which it occurs is a gray limestone full of other petrifactions. This lunate structure differs essentially from the one noticed by Dr. Dekay; the points of the crescent are rounded and do not curve towards each other; the terminations are not raised and translucent, but the whole surface is nearly flat. It however formed, undoubtedly, a portion of the under surface of some trilobite, whether that of an asaphus, an isotelus, or a dipleura, we are unable now to determine. In the Geol. Trans., No. 8, Vol. I, pl. 27, there is a figure by Mr. Stokes of what is said to be the under surface of the anterior portion of the shield of an asaphus platycephalus from Lake Huron. Dr. Buckland, whose copy of the figure we have only seen, observes concerning it, that the entrance to the stomach of the animal was between these lunate processes "analogous to that in recent crabs." The *A. phatycephalus* is synonymous with *I. gigas* of

Dr. Dekay; and if Mr. Stokes's drawing and Dr. Dekay's figure be accurate representations of nature, we think they must be drawn from analogous fragments belonging to animals at least specifically distinct.

In Mr. Wagner's cabinent there is another fragment of the under surface with lunate processes, somewhat resembling the one just described; but instead of being composed of a flat plate or surface, it forms one that is convex, very much resembling the figure given by Dr. Buckland from Mr. Stokes. From this fragment it is perfectly evident, that this lunate structure is composed of an upper and under plate, the one convex and the other plain or flat, so as to form, when united, a plano-concave, hollow, lunate box or cavity. The physiological relations of this structure I am unable to suggest; but since the above remarks were penned, I have seen a copy of *Murchison's Silurian System*, &c., from which the following extract is made, which may throw some light on this matter, and is otherwise interesting. "I have seen the work of *Pander* at too late a period to enable me to profit much by his views concerning the original structure of the trilobite or the adaptations of the tegumentary skeleton of the animal to its habits, into the consideration of which he enters at length. He certainly throws some new light on the nature of these creatures by exposing the interior or under surface—particularly that of their heads, in which he points out several divisions, and considers them to be the thoracic plate and jaws. The central portion, or that which was formerly described by Mr. Stokes from a North American specimen, he considers to have been connected with the head by cartalage only, and to have served as a *thoracic plate to protect the stomach*, the form of which varies in the different genera of trilobites found in Russia. On referring this subject to my friend Mr. W. Mc Lay, whose knowledge of invertebrated animals is so profound; he assures me that this plate on the under side of the head, above alluded to, must be considered as the *labrum* or upper lip. The trilobite is thus brought into close analogy with certain entomostracha such as the Apus Cancriformis, &c."

We have called the fossil remain which has occasioned the present remarks respecting the organization of the under surface of the trilobite, calymene bufo, a name which we proposed some years since in our little work on these interesting reliques. Other

writers have applied to it the term calymene macrophthalma, first given by Professor Brongniart, not only to this fossil, but to another, which differs essentially from it. He has given in his admirable work on this subject good figures of both animals, but his specific description refers only to plate 1, figure 4, A. B. He observes, "that the species is remarkable by the prolongation of the anterior portion of the buckler in the form of a snout, and that its middle lobe, or front, is marked on its sides by three *oblique plicæ* or wrinkles, like those on the *C. tristani.*" This description applies very well to some reliques found in the Dudley rock, which we have examined, but it is perfectly obvious that the calymene bufo, which has a rounded front, and is entirely destitute of plicæ or wrinkles, cannot be included in it. We therefore took the liberty in our little work of calling by the name of calymene bufo, the fossil represented on his first plate at figure 5, and which is so common in the United States; and of restricting the C. macrophthalma to the animals represented on the same plate at figure 4, which are specifically distinct, and if not so called, must still remain nameless.

Note.—Mr. Murchison in his magnificent work styled the Silurian System, has proposed the name of calymene Downingiæ for one of Professor Brongniart's fossils, called C. Macrophthalma, and restricts the term Macrophthalma to the one which I have named Calymene Bufo. There are several objections to this nomenclature. 1st, The C. Macrophthalma, *Brong.* was long ago divided into two species by me for the reason above stated. 2d, In M. Achille Comptès large pictorial illustrations of the Regne Animal, the C. Macrophthelma is represented by Brongniart's figure 4, A. B.; naturalists therefore already know it under that name. The following are Mr. Murchison's remarks on this subject: "I have separated the C. Macrophthalma, *Brong.* into two species, believing that his figure plate 1, figure 4, B, is our common large eyed species, and that his figure 4, A, of the same plate, judging from the ovate, accuminate head and the tubercles on the forehead is our C. Downingiæ. The last mentioned species is infinitely rarer than that to which I would restrict the name of Macrophthalma. That species is at once recognized by its bald, plain, rounded head, as is well exposed in the drawings of Mr. Stokes. See Brong. plate 1, figure 5, A, B, C. I have named this species after Mrs. Downing, to whom I am indebted for the loan of it."

ART. III.—*Description of a New Trilobite;* by JACOB GREEN, M. D, Prof. of Chemistry in the Jefferson Medical College, Philadelphia.

*Asaphus Diurus*—GREEN.

Clypeo? costis striatis, tuberculatis; cauda bipartita; corpore depresso.

The fragments of this Asaph which I have examined, consist of nineteen articulations of the abdomen and tail. The costal arches of the lateral lobes are very peculiar. They are marked by a shallow groove, or impressed line on their upper surface, studded on each side with quite a regular row of bead-like granulations. On each division of the vertebral column, there is but a single row of pustulations. The lunate caudal end is more expanded than in the cognate species, the *A. Selenurus*, and the concave side of the cressent, is more regularly rounded; the whole animal is much more depressed, than that species, and the lateral lobes are much wider in proportion to the middle lobe of the back.

There are two specimens of this fine species in the cabinet of William Wagner, Esq., of Philadelphia, both of which were found in Green County, Ohio, in the neighborhood of Xenia. The largest which measures two inches long and two and a half inches wide, is a plaster cast from a weather beaten natural mould; the other occurs in a grey, sparry, argillaceous limestone rock. It is perhaps worthy of remark, that all the specimens of the Asaph, with a lunate tail which I have noticed, were natural moulds, made by the animal in the rock, the shell or body having disappeared.

I was informed some time since, by Mr. Abraham Sager, of New York, that he had discovered several fine specimens of an Asaph with a lunate tail at the foot of the Helderberg mountains near *the Cavrs*, in which the horns of crescent which forms the caudal termination were remarkably elongated and perfect. As the A. Selenurus is found at Glenn's falls and at Becroft's mountain near the city of Hudson, is quite a different rock from that which occurs at the Helderberg, and as this last formation seems analogous to the one in which the Asaphus Diurus is found, it is probable that Mr. Sager's species may be the one now described.

I am indebted to the kindness of Mr. Wagner, for the opportunity of making out this species.

ART. IV.—*On the Natural History of Volcanos and Earthquakes*;* by Dr. GUSTAV BISCHOF, Professor of Chemistry in the University of Bonn. Communicated by the Author. Concluded from Vol. xxxvi, No. 2, page 282.

## EARTHQUAKES.

EARTHQUAKES, so closely connected with volcanic phenomena, are undoubtedly owing to the same causes. That the processes by which they are produced must take place at a great depth, is evident from the simultaneous occurrence of earthquakes at places far distant from one another. Some extraordinary examples in this respect are furnished by the memorable earthquake at *Lisbon*, on the 1st November 1755, which was not only felt over a great part of *Europe*, but extended to the northern coast of *Africa* and the *Antilles*; and farther, by the simultaneous shocks felt on the 16th November 1827, and *Ochotsk* and *Bogota*, which places are 1900 geographical miles distant from each other, and are separated both by land and sea.† Parrot‡ has calculated that about 700,000 German miles, that is, nearly one-twelfth of the whole surface of the earth, was shaken by the earthquake at *Lisbon*. Stukeley§ calculated from the extent of country over which earthquakes have been felt, that the force must, in some instances, be 200 English miles beneath the surface. But Daubeny‖ pointed out that we must not lay any stress on his remarks, because we have reason to believe that the vibrations may be propagated latterly far beyond the immediate influence of the impelling force. In a former

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* From the Edinburgh New Philosophical Jour., Vol. xxvi, No. 52, April 1839.

† Von Humboldt's Reise, &c., vol. i, p 497, and vol. iii, p. 23 and 27. Von Hoff, Verzeichniss Von Erdbeben, &c. in Poggendorff's Ann. vol. xxi, p. 214.

‡ Physik der Erde, p. 289. See also Berghaus' Almanack, 1837, p. 106, on the great extent of this extraordinary earthquake. With respect to this, it is worthy of remark, that *Vesurius*, which was in some excitement on the morning of the 1st November 1755, became suddenly quiet at the very hour of the shock; and that, as Von Hoff relates, the column of steam which rose, returned into the crater. The same happened during the earthquake in *Calabria*. The little volcano of *Stromboli*, which is continually active, subsided, and almost ceased smoking.

§ On the causes of earthquakes, Philos. Trans. for 1750.

‖ Loco cit. p. 388.

place, I have also shown, that the seat of volcanic action may be looked for at depths far less than Stukeley supposes. But there is no reason to believe that earthquakes could go on at greater depths than volcanic actions. Supposing that the interior of the earth is still fluid, and that rents conducting water, extend from the surface to the fluid nucleus, it is easy to conceive that the actions of the steam may be felt at very remote distances.

We have already pointed out the close connection which exists between earthquakes and volcanic eruptions. Von Humboldt, in his travels near the Equator, gives several examples of this. It may not be superfluous to refer here to what this illustrious philosopher asserts generally with regard to these phenomena, at the end of the 4th chapter of the 2d volume of Part I, Book 2.*

Every thing seems to show that earthquakes are caused by the effort of elastic fluids seeking an outlet. On the coasts of the *South Sea* their action is often communicated almost instantaneously from *Chili* to the Gulf of *Guayaquil*, a distance of 600 geographical miles; and, what is very extraordinary, the shocks seem to be so much the stronger, the greater the distance from the active volcanos. The granite mountains of *Calabria*, the limestone chain of the *Apennines*, the county of *Pignerol*, the coast of *Portugal* and *Greece*, *Peru*, and the continent of *America*, furnish striking proofs of this assertion.† It might be supposed that the earth would be more violently shaken, the fewer the openings on the surface which communicate with the interior. At *Naples* and at *Messina*, at the foot of *Cotopaxi*, and the *Tunguragua*, earthquakes are dreaded only when vapors and flames do not issue from the mouth of the volcano. In the kingdom of *Quito*, the great catastrophe of *Riobamba* led many well informed persons to believe that this unfortunate country would be less often disturbed if the subterranean fire would succeed in destroying the dome of porphyry of *Chimborazo*, and if this colossal mountain should become an active volcano. At all times, analogous facts have given rise to similar hypotheses. The ancient Greeks, who, like us, attributed earthquakes

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* See also what Von Buch says on *Vesuvius*. Geognostische Beobacht. vol. ii, p. 129.

† Fleuriau de Bellevue, Journ. de Physique, t. lxii, p. 261.

to the force of elastic fluids, brought forward, in support of their opinion, the total cessation of earthquakes in the island of *Euböa*, after the opening of a chasm in the Lelantic fields.*

The intimate connection of earthquakes with volcanos is not less clearly proved by the direction which the former take. With the assistance of a simple instrument (the sismograph) invented by Cacciatore, and erected at *Palermo*, it was found in twenty-seven cases that the shock was propagated in a fixed linear direction, which coincided remarkably with the cardinal points. In nineteen cases the shocks were transmitted in a direction from east to west, corresponding with the situation of Mount *Etna*, the source of all these subterranean concussions, which lies directly to the east of *Palermo*. In four cases it was from south to north; but, for want of corresponding observations, the seat of these shocks cannot be determined; and it certainly does not seem to have been the effect of chance, that three shocks, which were felt on the 9th February, 30th June, and 2d July 1831, traveled from the south-west to the north-east: for it was precisely in that direction, at a distance of about 70 Italian miles, that the small new volcano suddenly appeared in the sea, probably on the 2d July. The two latter shocks were also the very same that were felt with greater force at *Sciacca*, on the southern coast, opposite to the new volcano.†

On the other hand, Boussingault‡ asserts that the most memorable earthquakes in the New World, which ravaged the towns of *Latacunga*, *Riobamba*, *Honda*, *Caraccas*, *Laguayra*, *Merida*, *Barquisimeto*, &c., do not coincide with any well established volcanic eruption. The oscillation of the surface, owing to an erruption, is, as it were, local; whilst an earthquake, which is not subject (at least apparently) to any volcanic eruption, extends to incredible distances, in which case it has also been remarked that the shocks most commonly follow the direction of chains of mountains.

In favor of the hypothesis, that earthquakes are produced by aqueous vapor‖ penetrating to great depths, the following circum-

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* Strabo, lib. i, ed. Oxon. 1807, t. i, p. 85.

† F. Hoffman in Poggend. Ann. t. xxiv, p. 63.

‡ Annal. de Chim. et de Phys. t. lviii, p. 83.

‖ A remarkable case which has taken place at the iron-foundery at *Sayn*, proves, that shocks of the earth may be several times repeated by the effect of elastic flu-

stances may be adduced. Firstly, as aqueous vapor is supposed to produce volcanic action, it must be presumed to be also the cause of earthquakes. Secondly, some hours before the first shock of the tremendous earthquake at *Algiers* and the neighborhood, the 2d to 5th March 1825, which entirely destroyed the town of Blisa, all the springs and wells are reported to have been dried up.* Thirdly, earthquakes, though undoubtedly felt even the centre of large continents, seem to produce their most frightful effects in countries not very far removed from the ocean. But perhaps, earthquakes may also be produced by gaseous exhalations in the interior of the globe. At least in many accounts of earthquakes, mention is made of the exhalation of gases from rents, produced by them,† and the smell of sulphuric acid, and of sulphurous vapors, which indicate the presence of sulphuret-

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ids. A cylinder 14 feet in height, and 31,395 pounds in weight, was to be cast. The clay mould having been totally filled up by melted iron, the latter broke through the ground, and penetrated to the depth of 25 feet into the sandy soil, consequently 11 feet deeper than the lower part of the mould. Some time after an earthquake actually took place, which shook the whole building so violently, that the workmen feared it would be seriously injured. About half an hour after, an equally violent shock happened, and after more than 24 hours a third followed. The local circumstances of that iron-foundery lead to an explanation of these phenomena. There are at a depth of 23–24 feet under the ground of the said building, many inclined channels which communicate together, for the purpose of collecting the rain water. Immediately after the shocks, watery vapors issued abundantly from the mouth of the channels. These vapors were evolved by the heat of the melted iron from the water, being in the ground about two feet below the bottom of the channels; and penetrated through the joinings of their brick work. But these joinings being filled up with mud and sand, offered resistance, and consequently the vapors had to attain a certain elasticity before they were able to penetrate through them. It is, however, very probable that the vapors, bearing mud and sand with them, again stopped up the opening, when their elasticity gradually again decreased. During the shocks, the steam attained its greatest elasticity, and thickened the earth which surrounded the heated mass of iron; and this circumstance may have impeded a new afflux of water. Therefore, after the first shock, half an hour elapsed; and after the second, which still more obstructed the afflux of the water, even more than 24 hours elapsed before the third and latest shock took place.

* Berzelius, Jahresbericht, 1827, p. 310.

† Von Humboldt, Reise, t. i, p. 499. Von Hoff in Poggend. Ann. t. vii. p. 292, t. ix, p. 593, t. xxv, p. 76. V. Humboldt believes indeed, that during most earthquakes, nothing arises from the earth; but there are on the contrary, proofs that gases are often gradually evolved from the ground before and after the shocks. The uneasiness of small animals, or those whose organs of respiration are rather feeble, before and after earthquakes, leads us to infer this. Le Gentil (Nouveau Voyage autour du Monde, t. i, p. 172) has already observed, that animals living in

ted hydrogen.* These last may have occasioned also the destruction of the fish in the sea, and in lakes, during earthquakes; many instances of which are known. The bursting forth of flames from the earth and from the sea, which is so often mentioned,† also indicates the presence of inflammable gases. However, although this is corroborated by the fire-damp in mines, the disengagement of sulphuretted hydrogen while boring artesian wells, and the not uncommon exhalations of inflammable gas from the earth, yet it is difficult to account for their inflammation. This difficulty would disappear, if observation had found flames only to occur in really volcanic districts.‡ But at any rate, it is going rather too far to take the explosion of fire-damp for the cause of earthquakes, as Kries does.‖ It is not impossible, that what has been taken for flames, if not altogether an illusion, was only an appearance of light, produced by the sudden expansion of highly compressed gases, exactly the same as is seen when an air-gun is discharged in the dark.

The heating and boiling up of the water in the sea and in lakes, the spouting up of streams of water, as well as the ejection of various substances from fissures in the earth,§ which have oc-

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holes, as rats, mice, reptiles, &c., *commonly quit their abodes shortly before earthquakes.* Crocodiles quit their pools in the *Llanos*, and remove to the continent, Relat. Hist. t. v, p. 57. Von Humboldt moreover relates that dogs, goats, and particularly hogs, which have a keen smell, and turn up the ground, are suddenly affected, and a great number of these latter animals have been found suffocated during the earthquakes in *Peru.*

* Von Humboldt, ibid. t. i, p. 484, and t. ii, p. 73. Von Hoff, ibid, t. xii, p. 567, t. xviii, p. 46. See also Philos. Trans. t. xlix, p. 415.

† Von Humboldt, ibid. Gehler's Physikal. Wörterbuch, new edit., t. iii, p. 804. Also during the earthquake of *Lisbon* (Philos. Trans. ibid.) and on the island of *Matschian,* (Hist. de la Conquête des Molluques, t. iii, p. 318) the bursting forth of flames is reported to have taken place.

‡ Von Humboldt mentions flames which rise from time to time out of two extensive caverns in the ravine of the *Cuchivano.* This phenomenon was accompanied, during the last great earthquake at *Cumana*, with a continued hollow subterranean noise. The flames are more especially to be seen during the rainy season.

‖ In his prize essay on the causes of earthquakes.

§ Von Hoff l. c. t. xxv, p. 73, t. xxix, p. 421. At the time of the earthquakes, which destroyed a part of *Italy*, (1702–1703.) many rents were formed in the *Abruzzi*, which emitted a large quantity of stones and then troubled water. The latter was thrown up higher than the trees in the neighborhood. Flames and a thick smoke rose from the neighboring hills, which continued three days with some interruptions. Hist. de l'Acad. an. 1704, p. 10. During the earthquake,

casionally been witnessed, may be satisfactorily explained by the rising of steam and gases, which may have the effect either of heating the water, or of throwing out solid bodies.* The same may be said of the concussions of the earth which take place, sometimes in horizontal undulations, sometimes in vertical shocks, and sometimes with a vibratory motion, backwards and forwards. The latter of these convulsions, called by the Neapolitans, *moto vorticoso*, is most common during the greatest earthquakes.

Von Humboldt has proved, by abundant examples, that the propagation of earthquakes is not confined to any particular rock, but that the most varied formations are equally favorable to it. We infer, therefore, that the seat of earthquakes must be below all known rocks. Although all the rocks may be agitated, yet the manner of extension of the shocks in them is different, according to their particular quality. The earthquakes, which

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the 21st October 1766, which totally destroyed the city of *Cumana*, the earth opened at several places in the province, and vomited sulphureous water. These eruptions were particularly numerous in a plain, which extends towards *Casanay* two geographical miles eastward of *Cariaco*, and which is known by the name of the *hollow land* (*tierra hueca*) because it seems to be every where undermined by hot springs. Von Humboldt, Reise, t. i, p. 482. During the violent earthquake, which in one minute overthrew the city of *Caraccas*, on the 26th March 1813, so much water was thrown up through the cracks, that a new stream was formed. At the same time the ground was also found covered with a fine white earth, like volcanic ashes, which had been thrown up from fissures in the neighborhood. The eruptions of volcanic masses were still more considerable during the earthquake of *Riobamba*, 1797. The earth was fissured at innumerable places, and immense gulfs were formed in some places. Masses of water rose, filling up valleys 1000 ft. wide, and 600 ft. in depth; and also at the same time a peculiarly stinking mud, consisting of volcanic matter, accumulated so as to form considerable hills, now called *moya*. Wide rents were likewise opened during the violent earthquake in the north coasts of *South America*, last year, in order to give exit to streams of water which rose. It was often observed, that during the earthquakes, water with sand, mud, &c., was thrown up from wells, sometimes to a height of 30 ft. Von Humboldt relates, (Relat. Hist., t. ii, p. 287,) that this phenomenon is generally observed during the earthquakes at *Cumana*. The same thing happened the 1st Nov. 1755 near *Colares*, (Philos. Trans. t. xlix, p. 416,) and also during the earthquake in *Calabria*. (Journ. de Phys. lxii, p. 263.)

* Thus, during the above-mentioned earthquake on the north coast of *South America*, columns of smoke were seen rising out of the sea, a league from the shore, and in a depth of about 210 ft.; and in the night, flames were seen issuing from the same spot, which illuminated all the coasts of the island. After each shock, the sea retired, left the ships which were in the bay aground, and laid bare the rocks to a great depth; the waves at the same time ran to a height of 16 ft. to 20 ft. During the shocks the earth opened and closed again very rapidly. When

have at different periods ravaged *Smyrna*,* *Messina*,† *Kingstown* in *Jamaica* 1792, the county of *Pignerol* 1808,‡ *Calabria*,‖ *Talcahuano* in *Chili*,§ &c., have always had a greater effect on diluvium and alluvium, than on rocks. Houses, for instance, built on sandy ground, were demolished, while those which stood on rocks were but little damaged. The shocks therefore act less violently and destructively on solid and rocky ground than on loose soil, which is unable to resist, and propagates the shock irregularly. In *Calabria*, where the loose soil occurred lying on granite on the declivity of the hills, the latter threw off the former, which glided down. Lastly, there are also instances of shocks extending irregularly in rocks.¶

Many instances present themselves of earthquakes, which in extending longitudinally, follow the direction of the rocks. This is the case, according to Palassou,** in the *Pyrenees*. Remarkable instances are presented in the phenomena of the 28th Dec. 1779; the 10th July 1784; the 8th July 1791; the 22d May 1814, &c. The regions situated more to the south, are, however, more affected than the chain itself.†† Earthquakes in *South America* seem also to follow the direction of the mountains. Thus, that at *Caraccas* (1812) followed the direction of the littoral *Cordilleras* from E. N. E. to W. S. W.‡‡ That of *Cumana* 1797, presented an instance of the same fact. The predominant direction of the frequent earthquakes on the coasts of *Chili* and *Peru*, is also that of the large chain of the *Andes*, which is parallel to the coast.‖‖ All the older reports likewise state, that in these countries their direction is from S. to N., or *vice versa*; and Mrs. Graham remarked, that she felt, during the violent earthquake in *Chili* 1822, as if the whole ground from north to south

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tranquillity was restored, a whirlpool was observed in the sea, as if the waters were being swallowed up in an immense gulf. The temperature of the sea in the bay was raised, and bubbles of gas were seen rising all over the surface.

* Hist. de l'Acad. des Sciences, an. 1688. Buffon, Hist. Nat. t. i, p. 515.

† Spallanzani, Voyage, t. iv, p. 138. ‡ Journ. de Phys. t. lxvii, p. 238.

‖ Oryktologische Bemerkungen über Calabrien &c., 1784.

§ Nautical Magazine, Nos. 49 and 51, March and June 1836.

¶ Berghaus' Almanack für das Jahr 1837, p. 72.

** Mém. pour servir à l'Hist. Nat. des Pyren., p. 260.

†† Ibid p. 916. ‡‡ Von Humboldt, Rel. Hist. t. v.

‖‖ That at *Cumana* followed the direction from N. to S., which is extremely singular, l. cit. t. iv, p. 16.

were suddenly raised, and then sunk again. Von Hoff* has also related the circumstance, that the shocks of earthquakes are most common in the same direction as that of the basaltic masses themselves, and around a certain distance on either side of the line in which they occur.

On the other hand, there are many instances of the countries of Europe having been agitated in all directions, without having been influenced by the mountains. Thus, earthquakes have extended from *Upper Italy* across the *Alps* to *Switzerland.* That at London (19th March 1750) followed the direction from W. to E., although the direction of the mountains in *England* is from S. S. W. to N. N. E. &c. Sometimes the earthquakes originate from a common centre in a radiating direction on all sides. That of *Lisbon,* (1755,) that in *Calabria* (1783,) and that at *Lima* (1746,) &c., offer instances of this kind.

With regard to the earthquakes in *South America,* it has been observed that they occur principally in the mountainous countries. The cause which produces them, seems, as Boussingault† believes, to be so constantly in operation, that, if all the earthquakes, which are felt in the inhabited countries of *America,* could be noted, the earth would be found to quake nearly without intermission. These frequent movements of the ground of the *Andes*, and the slight coincidence between these convulsions and the volcanic eruptions, induce us to adopt the opinion of Boussingault, that the former are, for the most part, independent of the latter. He ascribes the greatest number of the earthquakes in the *Andes* to the sinking of rocks in the interior, which is a consequence of the former elevations of these chains of mountains. In favor of these suppositions, he affirms that these gigantic rocks have been thrown up, not in a doughy, but in a solid and fragmentary state, but that the consolidation of these fragments of crystalline rocks might not at first have been so firm, as not to admit of some sinking after the elevation. He refers to the Indian tradition which preserves the memory of the sinking of the celebrated mountain of *Capac-Urcu*, near *Riobamba*, the name of which signifies the chief, *i. e.* the highest, of all the mountains near the Equator. It is said that the top of this

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* Geschichte der Veränderungen der Erdoberfläche, t. ii.

† Annal. de Chim. et de Phys., t. lviii, p. 83.

mountain has sunk in consequence of a subterranean shock which took place before the discovery of *America*. At the present time *Capac-Urcu* is lower than *Chimborazo*. Boussingault alludes to many instances, in which it is asserted, that the *Cordilleras* have sunk. Without taking into consideration the inferences drawn from barometrical measurements, made by Boussingault and his predecessors, which seem indeed to confirm that supposition, we will only mention the following circumstances. The French academicians, who, a century ago, were sent to *Quito* for the purpose of determining the form of the globe, were very much embarassed in their station on *Guaguapichincha*, by the snow surrounding their signals. Now, for many years, no snow has been found on the summit of this mountain. The inhabitants of *Popayan* have also remarked, that the inferior limit of the snow covering the *Purace* is gradually rising, whilst the mean temperature has remained the same for the last thirty years, whence Boussingault infers, that the *Purace* is sinking down.

That masses thrown up in a state of igneous fusion sink again by degrees, in consequence of their consolidation and contraction, cannot be doubted. But even if their elevation had taken place in a solid state, yet the immense masses of the *Andes* have risen from depths, where a pretty high temperature prevails. Supposing the *Andes* to have risen 24,000 feet in height, that part of them which is now at the level of the sea, must have been before the elevation so many thousand feet below it. This part brought, therefore, with itself from beneath, a temperature which was $\frac{24000}{51} = 470°$ F. higher than that which existed at the level of the sea before the elevation. The same holds good of each part of the *Andes*, in any depths, so that every where in erupted masses the temperature surpassed that of the adjacent rocks by 470° F. Whilst now these masses gradually lost their surplus of heat, they were contracted. But this cooling of these masses can, as far as they are within the earth, only be affected by conduction, therefore a long period will elapse for that purpose. That part of the *Andes*, which is elevated above the surface of the earth, and is exposed to the atmosphere, will of course cool a little more quickly. If the bases of the rocks thrown up be at a great depth below the surface, their contraction in consequence of their cooling may be very considerable, and as the elevation



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of the *Andes* is said to be one of the latest, this cooling and contraction may continue even at the present time in that part which is within the earth. It is therefore possible to conceive that these effects are the cause of the frequent earthquakes in the *Andes.*

Besides, there is nothing opposed to the hypothesis, that the powers, whatever they may be, which produced so remarkable a phenomenon as these elevations, may not even now operate in a less degree, and occasion the earthquakes so frequent in the *Andes.* The later these elevations are supposed to have taken place, the more probable will such a hypothesis be.

If further proofs are still necessary to show that the causes of earthquakes are only to be sought in the interior of the earth, we certainly find them in the fact, that these phenomena are totally independent of external circumstances. They take place whether the sky be clouded or serene, in hot as well as in cold weather,* before or after rain, sometimes with rain, and sometimes without it. Even the strength and direction of the wind seem to have no kind of connection with them.† Nor do they seem to be

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* Many observers allude, indeed, to variations of temperature of the atmosphere before and after earthquakes; but the academicians of *Turin* only have actually made observations on the temperature in the county of *Pignerol.* (Journ. de Phys. t. lxvii, p. 292.) They found that their thermometer always descended as soon as shocks had been felt. Thus they felt a vehement shock in the morning at half-past ten, on the 10th of April, and their thermometer descended till noon from 26° to 22°. In fact it is to be desired, that farther observations should be made on other occasions, in order to confirm or refute the assertion of so remarkable a phenomenon.

† The late F. Hoffman in vain endeavored to discover in the Meteorological Journal of the Observatory of *Palermo,* (which included a series of years from 1792 to 1832, and where particular attention had been paid to the observation of earthquakes, of which no less than fifty-seven had there been accurately observed,) some peculiarity of weather, which might, with any degree of plausibility, be supposed to have been connected with the earthquakes. The same result was obtained by Domenico Scinà in his memoir on the numerous earthquakes, which, in the years 1818 and 1819, caused so much apprehension in the neighborhood of the *Madonian* hills —Poggendorff's Ann. t. xxiv, p. 50 and 60. In contradiction to this are the traditions current in many countries. See among others, Berghau's Almanack, 1837, p. 97, and following. There seems to be in fact, some truth in the opinion, that earthquakes are most frequent and vehement at the beginning of rainy weather, and this phenomenon is even ascribed in *Jamaica* to a locking up of the pores in the crust of the earth by water, which impedes the rising of gases. On the other hand, cases have occurred in which earthquakes, were preceded by a long continued drought.—Barham in the Philos. Trans. t. xxx, p. 837, y. 1718, and t. xlix, p. 403; Relat. Hist. t. ii, pp. 273, 281, and t. v, p. 15, and 57; Hans

confined to any particular season of the year, although it is certainly remarkable, that of fifty-seven earthquakes, which were felt at *Palermo* during a period of forty years, almost a fourth part happened in the month of March.* Perhaps the best means of ascertaining whether any connection exists between earthquakes and meteorological phenomena, is the observation of the barometer. But Hoffman was unable to discover anything peculiar or extraordinary, either in the relative height of the barometer, in the direction of its motion, or in the extent of the oscillation, during the fifty-seven earthquakes above alluded to. The oscillations never went beyond their ordinary limits; indeed, in most cases they were very inconsiderable.† Von Humboldt also says that between the Tropics, on days when the earth is agitated by violent earthquakes, the regularity of the hourly variations of the barometer is not disturbed.‡

If aqueous vapors and compressed gases are the cause of earthquakes, there can be no doubt that hot springs and exhalations of

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Sloane's Letter with several accounts of the earthquake in Peru, October 20th, 1687, at Jamaica, 10th February, 1688, 7th June, 1692; ibid, y. 1694. p. 78; Hist. des Trembl. de Terre, t. ii, p. 442; Collect. of the Massachusetts Hist. Soc., t. v, p. 223.

* Hoffman, loco cit. p. 52. It is also well known that in other countries, especially in *Chili* and the *Moluccas*, the periods of the equinox, for reasons of which we are ignorant, are considered as those most favorable to earthquakes. During the above named period of forty years, this law does not seem to have been applicable to the autumnal equinox in that part of *Europe*.

† During the earthquakes the barometer stood decidedly oftener above the mean than under it. However, Hoffman remarks, p. 56, that during the only shock of importance which occurred in this period at *Palermo*, viz., in March, 1823, the barometer remained the whole month constantly below the monthly mean.

‡ Reise, t. i, p 487; also Relat. hist. t. iv, 19. Likewise Boussingault in Ann. de Chim. et de Phys. t. liii, p. 82. Other observations have also proved that the height of the barometer is totally unconnected with the cause of earthquakes, as for instance those of Don Felixe Castillo Albo, during the earthquake in *Chili* in the year of 1822. See also Meyen in his "Reise um die Erde," t. i, p. 210. Those also made in the county of *Pigneral* in *Savoy*, by the committee of the academy of *Turin*, during the earthquakes in the year 1808. The state of the barometer was also invariable, whilst the shocks at *Lisbon*, the 9th December, 1755, were very strongly felt at *Turin* Philos. Trans. t. xlix. The observations made on the island of *Meleda*, near the coast of *Dalmatia*, from the 15th November, 1824, to the 28th February, 1826, which likewise prove, that no connection exists between earthquakes and the pressure of the atmosphere, are very important, the shocks felt on this island having been the only ones of their kind as regards length of duration.—Die Detonations-Phänomene auf der Insel Meleda von P. Partsch, Wien, 1826, p. 204.

steam and gases, may act as vents, and thus serve as a protection against them.*

Indeed, the ancients endeavored to diminish the violence of subterranean explosions by means of wells and excavations. What Pliny,† the great Roman naturalist says of the efficacy of these expedients, is repeated by the ignorant inhabitants of *Quito*, when they point out to the traveller the *Guaicos*, or clefts of the *Pichincha.*‡ But this is by no means confirmed by experience.

### *Farther reasons in support of the hypothesis which attributed volcanic phenomena to increased temperature of the interior.*

However distinct natural philosophers may consider the causes of volcanic action, and those of hot springs, yet the close connection of these two classes of phenomena refers us to one and the same cause. In proportion as satisfactory grounds can be adduced in support of any hypothesis, which explains one class of phenomena, so much the more probable does the hypothesis appear when applied to the other class. Though the seat of hot springs be concealed deep in the interior of the earth, and be as little accessible to immediate observation and investigation as volcanic action is; yet we may pursue and examine the phenomena of the former on the surface of the earth, and every point of time selected by the observer for this purpose proves equally favorable.

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* Hoffman is inclined to ascribe the rarity and weakness of the earthquakes at *Sciacca* to the numerous exhalations of aqueous vapors, and to the great number of hot sulphurous springs, which occur in that neighborhood, compared with other parts of *Sicily*, that are so often and so terribly visited by these destructive phenomena. *Poggendorff's Annal.* t. xxiv, p. 70.

† Lib. ii, c. 82 (ed Par. 1723 t. i, p. 112)

‡ Von Humboldt, Reise, t. i, p. 491. In *Peru*, the earthquakes are less frequent than in *Latacunga*, which is ascribed to the great number of deep hollows which intersect the ground in all directions in the neighborhood of the town. Leonhard's Taschenbuch, 1822, p. 917. Von Hoff quotes many instances, in which several wells in *Rome*, *Naples*, and *Capua*, are said to have diminished or totally paralized the effects of earthquakes. But, in my opinion, an undue importance is ascribed to this effect of wells, for it is hardly to be conceived, that the effects of a cause, existing so deep in the interior of the earth, should be modified in any considerable degree, by an opening which penetrates the crust of the earth to so slight a depth.

Their wide distribution, the invariableness of their phenomena, the evolutions of gases from many of these, present to every attentive observer, matter of investigation and consideration on their origin, duration, and connection with other phenomena. If, then, we can succeed in proving that chemical processes can with much less probability be assigned as the cause of their being heated, that on the other hand, the most convincing reason show that their heat is acquired at the expense of the interior of the earth: then will the hypothesis, which endeavors to explain volcanic phenomena from the same causes, gain no little increased weight. And in fact if hot springs be heated to such a degree as to attain the boiling point at a certain depth in the earth, we have but one step to make, by supposing this heat increased up to the fusing-point of volcanic stony masses, in order to attribute with equal probability, volcanic phenomena and hot springs to the central part of our earth.

I must observe, in the first place, as was formerly remarked, that, by thermal springs, I understand nothing more than springs whose average temperature exceeds that of the soil at the level at which they rise. It is therefore indifferent whether this excess consists in 1° or less, or in 50° or more. I can form no other idea of the meaning of the word thermal springs; at least, I do not know what degree of temperature can be laid down as the boundary between cold and thermal springs, unless the distinction were to be perfectly arbitrary. Thermal springs (taken in this sense,) are very widely distributed over the globe, as I think I have formerly shown. Nay, I am convinced that, if we take any district of nearly equal height above the level of the sea, several of the springs will be found to exceed in average temperature that of the soil. An exception to this rule will certainly be found only in those situations where springs arise at the foot of hills more or less high and which have acquired a cooler temperature from the higher regions.

If, like Professor Daubeny,* we regard chemical processes going on in the earth as the cause of thermal springs, then must these processes be as universally distributed as the thermal springs. Those who entertain these views, however, do not surely con-

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* Report on the present state of our knowledege with respect to mineral and thermal waters. *London*, 1837.

tend, that these processes take place near to the surface, else how could we explain the fact, that, in boring Artesian wells, the greater the depth, from which the water rises, the higher is its temperature. As little explanation could be given of the circumstance, that springs rising in a small district near one another, often present no inconsiderable difference in their average temperature. In proof of the former assertion, I will cite out of many other instances that of the hole bored at *Rüdersdorf* near *Berlin*, where water at 74°.3 F. was drawn by boring to a depth of 880 feet; and in proof of the latter, the numerous springs in *Paderborn*, whose temperature varies from 49° to 61°. F. In the former case, then, these presumed chemical processes must take place far below the depth of 880 feet; in the latter they must be supposed to be going on, either entirely below the situation of the springs at a nearly equal depth, or at various depths beneath each separate spring. In the previous case, their different temperatures would be occasioned by one spring running nearer, the other at a greater distance from, the common source of heat.

Daubeny speaks, in general terms only, of chemical processes; if we may, however, judge from a note,* he seems to allude to the same processes as those which he assumes as the cause of volcanic phenomena, viz., the oxidation of metals of alkalies and earths by water. We may pause a little to consider these hypothetical chemical processes, as they ought to inform us whence the agent, viz., heat, is derived, which is the point in question.

As the presence of thermal springs is so universal, these metals must be equally so. This hypothesis, especially in the extent given it by those who maintain it, viz., that the whole nucleus of the earth consists of an unoxidized mass, cannot be reconciled with the proportionate density of our earth, as I have already shown. Yet, let us admit for a moment the existence of these metals in a more limited proportion. Their oxidation requires the access of water; we must, therefore, suppose as many channels to conduct the water from the surface as there are thermal springs, or at least groups of thermal springs. Granting all this, the question yet remains to be answered, why the effects of

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* Report, &c., p. 68 and 69.

these subterraneous oxidations are seen on the surface, in and near volcanos only; and why not even a trace of such processes can be detected in other places, which yet present innumerable thermal springs? Surely no one will bring forward the scanty evolutions of sulphuretted hydrogen gas from sulphurous waters as proofs of such processes. But, were the conditions necessary for volcanic activity fulfilled by the access of water to the interior in each of these channels, then would the occurrence of volcanic phenomena be much more frequent on our earth. Or, it must at least be assumed that they were at a former period as universally distributed as thermal springs now are; and that they have left behind a high temperature in the interior, which warms the springs, and, as Daubeny also assumes, extricates from the limestones, in the interior, the carbonic acid gas so universally present. That this is occasionally the case, namely that springs do acquire their heat at the expense of volcanic masses elevated at a distant period, is certainly true, and has probably been of still more frequent occurrence in former times. I have myself already adduced instances of this kind. With the cooling of these masses, however, the thermal springs dependent on them must of course also cool, and whether this cooling take place in a longer or shorter time, must depend on the greater or less extent of those masses.

After the preceding remarks, the question remains, whether it be necessary to assume, in explanation of the universal distribution of thermal springs, a volcanic activity once so universally distributed; or whether their existence cannot be both more simply and more satisfactorily explained by an increased temperature in the interior, which is by no means merely hypothetical, but is supported by innumerable facts.

Daubeny says,* "That (the supporters of my views) should explain to us why primary rocks, traversed, as they so frequently are, with fissures of all descriptions, should not in every part of the world, and in every kind of situation, give rise to hot springs, by evolving steam from their interior, and why they never appear to give issue to that class of thermal waters which I have noticed in *Ischia*, as being unaccompanied with gaseous products."

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* Report, p. 70.

A spring arising from beneath, leads us to conclude that meteoric water penetrates through clefts which communicate low down with the former. The experience gained in boring artesan wells, shows that a succession of strata is most favorable for such processes, and from causes easily explained. In what are called primary rocks, however, no such alteration of strata is found, because they are not stratified. The usual occurrence, viz., the flowing of meteoric water down inclined surfaces of stratification which appear at elevated situations, and the rising of this water, by means of natural or artificial channels, after having been forced down to a more or less considerable depth, cannot then happen in unstratified rocks. It appears, nevertheless, that there are granitic rocks traversed by clefts more or less perpendicular, and communicating low down. Thus at *Aberdeen*, in *Scotland*, water has been drawn by boring in granite 180 feet below the surface, which, according to Robison, came from a cleft filled with sand and gravel, and rises six feet above the level of the earth.* Such a communication of the clefts low down, must, however, occur but rarely.

If the primary mountain rises above its environs and the clefts at its base lie exposed, then will the springs flow out of the clefts. Such an origin of springs, which are not naturally rising springs, is often observed at the foot of basaltic and trachytic cones, &c.

On the other hand, on the limits between stratified and unstratified rocks, where the latter have traversed the former, and where channels extending to a great depth have been formed in consequence of the contraction of the traversed masses during their cooling, circumstances favorable to these rising springs exist, and it is easy to conceive, therefore, that thermal springs may be found on the limits of these interrupted masses, but not in their interior.

Let us imagine a stratified chain of mountains consisting of several formations in a perfectly horizontal position, whose newest portion (jüngstes Glied) is much fissured, and under which an impervious stratum lies, then the meteoric water will penetrate the former fissured stratum, but be retained by the latter. As long as this horizontal position remains undisturbed, no rising

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* Compt. Rend. 183 No. 24, p. 575, and t. ii, No. 20, p. 583.

springs can be supposed to exist in the whole of this district, and the inhabitants of such mountains could only supply their want of water by wells (Senkbrunnen.) We will now suppose, that at two points of this district, volcanic masses are thrown up, and that, in consequence, a partial elevation of the strata takes place, as is shown in the diagram, fig. 1. In this case, the hydrographic relations undergo considerable alterations. The consequence will be not only a movement of the water on the impervious stratum, in the direction of its inclination, but meteoric water will also penetrate at A between the older strata, where, during their undisturbed horizontal position, not a drop of water could penetrate, and this water will continue to flow in the direction of the inclination of the elevated strata.* At B, where these strata

Fig. 1.

are also elevated, but to a lower level, springs will commence rising ; and as many of such springs may be supposed to exist in a district, as there are alternations of impervious and pervious strata in these mountains. The most copious springs, however, will be found between the mass that has been broken through, and the oldest formation of the stratified mountain, because here, in consequence of the contraction of the former mass during its cooling, a cleft has been formed, which receives the meteoric water flowing down on that side of the elevated mountain C, which lies next to the raised strata. The meteoric water which flows down through the newest fissured stratum, will now as little give origin to rising springs as during its earlier horizontal position. If, now, after the period of this elevation, a stratum of a new formation should occur, covering the extremities of the older raised

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* The same holds good with regard to the springs of fresh water Thus on the *Schwabisch Alp* springs are always found there where cones of basalt or basaltic tufa have been elevated on the jura-formation. Plieninger in Poggendorff's Annal. t. xl, p 493.

strata, and extending from B to D, and if, lastly, the new formation contain impervious strata, then the conditions will undergo a change. The meteoric water, which penetrates at A, between each separate portion, will now all issue in the form of rising springs at B, between the elevated mountain and the new stratified formation which lies at its side. Should any obstacle here present itself to its exit, the water will even take a retrograde course B D, and issue at D, in which case the water between the last formed horizontal stratum and the impervious stratum lying under the newest raised ones will unite with it. We will not, however, enter into farther particulars, as many circumstances may be supposed to exist which modify the course of the springs; and still more complicated relations naturally arise, when, after the deposition of the latest formed stratum, the elevation and raising are repeated. It will be sufficient to have called attention to the circumstance, that rising springs can exist only when the originally horizontal position of the stratified formations has been destroyed by elevations; and that the most copious springs, and those which arise from the greatest depths are found precisely at the limits between the elevated masses and the raised strata.

Numerous instances can be cited in proof of this assertion. The *Pyrenées* and *Alps*, present very characteristic circumstances. Thus Pallasou* shows, that not only are the majority of the hot springs in the *Pyrenées*, situated in the great granitic district at the eastern side, but also, that all the others issue only from hollows of the newer formations, where the granite rises from beneath, at the foot of the declivities. He shows also, that even the degree of temperature of these springs depends on the greater or less exposure of their source; for the thermal springs nearer the principal granitic mass are warmer, while those more remote are colder.

Professor Forbes has likewise pointed out, in an interesting memoir on the temperatures and geological relations of certain hot springs, particularly those of the *Pyrenées*,† that, in the departments of the *Arriège* and the *Pyrenées Orientales*, where granite formations preponderate, in almost every case which he

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* Mém. pour servir à l'Hist. Natur. des Pyrenées, 1815, p. 435, 459.

† Philos. Transact. for 1836, p. 575.

has examined, if springs rise in granite, *it is just at the boundary of that formation with a stratified rock.* In a great many cases it happens, that part of the springs rise from granite, and part from the slate or limestone in contact with it; and, he correctly observes, a more striking instance of the immediate connexion between thermal waters and disturbed strata could not be desired.*

According to the observations of several geologists, the tertiary rocks in the *Pyrenées* extend horizontally to the foot of this chain, without entering, as the chalk, into the composition of any part of its mass. Elie de Beaumont thence infers that the *Pyrenées* received their position, relatively to the neighboring parts of the earth's surface, between the period of the deposition of green sand and that of chalk (a formation, whose raised strata, according to Dufrénoy's observations, ascend to the crest of this chain,) and before the deposition of the tertiary strata of various ages.† We can very well explain, according to this supposition, why the springs in the Pyrenées issue between the elevated granite and the raised strata of slate and limestone. The circumstance above quoted from Pallasou, viz., that the temperature of springs becomes lower, in proportion to their distance from the principal granite-mass, may perhaps be of little importance, since, according to the remark of Forbes, cold sulphureous springs are to be found, even within not many yards of others, having a high temperature, and almost an identical mineral composition. Of this he has met with two examples in very different parts of the chain, one at the *Eaux Bonnes*, where a perfectly cold spring rises within two hundred yards of the principal hot spring of the place, has similar medicinal properties, and is even more strongly impregnated with sulphur. The other example occurs at *Las Escaldas*, on the southern declivity of the *Eastern Pyrenées*, where a most efficacious cold sulphureous spring rises within about one hundred yards of a hot one. When, Forbes continues, to these facts we add others scarcely less curious, of springs of totally different mineral composition issuing from nearly the

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* At *St Sauveur* and *Thuez*, we have the co-ordinate, and, as Forbes p. 602, rightly thinks, connected phenomena of intrusive rocks, dislocations or fissures, metalliferous impregnation, and hot springs.

† See Poggendorff's Annalen, t. xxv, p. 26, also p. 58.

same spot, and with temperatures from 160° to 180° Fahr., as we see at *Ax* and at *Thuez*, we are forced to conclude that the source of mineralization must be independent, to a great extent, of that high temperature, and that the arguments, as to the origin of thermal springs founded upon their chemical composition, must be to a certain degree fallacious.

The origin of the sulphureous waters in the Pyrenées can scarcely be sought for in the granite, since no substances are contained in it which can be supposed to produce such springs. If such springs are formed by the decomposition of sulphates by means of substances containing carbon, it is very probable,* then we must look for the origin of the *Pyrenean* sulphureous waters in the secondary formations, perhaps in some coal stratum, or even possibly in the tertiary formations. This inference holds, even if the sulphureous springs are formed in a manner opposite to this view. If, now, the origin of the springs in question, in other words, if the materials necessary for their formation be present in one of the newer parts of the secondary formations, then warm or cold sulphureous springs will result, according as warm or cold water penetrates to this point. The granite plays, then, no other part here, than that of rendering possible the descent of meteoric water to great depths, and its re-ascent in consequence of the raising of the strata effected by the granite, which circumstance causes the heating of these waters.

In this point, I think both theories agree; viz., that which attributes the heat of springs to chemical processes, and that which refers its origin to central heat: for those who hold the former opinion will doubtless not assign the stratified formations as the seat of these chemical actions, but the granite, or the parts beneath it. According to both theories, then, the meteoric water will become warmer in proportion as it approaches nearer to the source of heat, which can be sought for only at great depths.

As the subterraneous course of springs is subjected to many kinds of local impediments, so veins of springs of similar origin may flow out at points very remote one from another; and, *vice*

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* See my memoir in the *Neues Jrhrbuch der Chemie and Phys.* t. vi, p. 251, year 1832. The proportionally large quantity of organic matter in the *Pyrenean* sulphureous springs (among which that of Barégine, so called from the valley of *Bareges*, is remarkable) speaks but little in favor of their origin from a mountain **produced by volcanic fire.**

*versa*, veins of very dissimilar local origin may issue very near one another. Nothing is therefore easier to conceive, than that any stratum in which the materials requisite for the formation of sulphureous springs at present, may be traversed by springs arising from very various depths, and therefore possessing very unusual temperatures, which circumstance would give rise to springs of similar chemical composition, but dissimilar temperature.

Forbes* remarks that the hot springs at *Baden-Baden*, on the border of the *Schwarlzwald*, have a position almost identical with that which we have so invariably remarked in the *Pyrenées*. They occur just where the slate rocks have been violently upraised by a curious granitoidal porphyry, which forms the picturesque elevations near the *Alte Schloss*, and which passes into a true granite. Upon the slate, red sandstone lies unconformably. The elevation is among the older of M. Elie de Beaumont's systems: he expressly states that the *Grès bigarré* is undisturbed.

Relative to the thermal springs in the *Pennine Alps*, Bakewell† remarks, that, according to his observations, the exits of all of them lie partly in the primitive mountains of the central chain itself, partly, and indeed most frequently, at their extremities, at the boundary between the primitive mountains and the secondary formations.

According to the beautiful investigations of De Beaumont, two different systems are to be distinguished in the Alps, viz., that of the Western Alps, and that of the principal chain from the *Valais to Austria*. *Mont Blanc* lies at the point of intersection of these two systems, which here meet at an angle of 45°–50°; also *Leuk*. The period of elevation of these two systems falls somewhat late. That of the strata belonging to the first system took place after the deposition of the newest tertiary formations of these regions, and that of the strata belonging to the second system between the deposition of the earlier diluvium (*des ältesten aufgeschwemmten Landes*) and the flowing of the diluvial streams, and at the time of the transport of the erratic Alpine rocks. The most favorable conditions for the origin of thermal springs evidently exist when the upraising, caused by the masses

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* L. c., p. 609. † Philos. Magazine, January, 1828, p. 14.

thrown up, extends to the newest formations. Therefore we are justified, under these circumstances, in expecting to find many thermal springs in this district, and especially at those points where two different systems of elevation have intersected each other at different periods, and admitted the meteoric water to penetrate to the interior. The thermal springs in the *Pennine Alps* are found partly in the direction of the principal chain of the *Alps*, partly, and more abundantly, in the points of intersection of this system with that of the Western *Alps*, and in this last system. Thus at Naters in the Upper Valais, (86° Fahr.;) at Leuk (115°–124°;) in the valley of *Bagnes* at *Lavey*, south-east of *Bex* (113°;) *Saute de Pucelle*, between *Moutiers* and *St. Maurice*, in *Chamouni;* St. Gervaise on *Mont Blanc* (94°–98°;) *Courmayeur* and *St. Didier*, on the southern declivity of *Mont Blanc* (93°;) *Aix les Bains* in *Savoy* (112°–117°,) with numerous hot springs in the neighborhood; *Moutiers* in the *Tarentaise*, *Brida* in *Tarentaise*, and some at *Grenoble.*

It certainly deserves particular notice, that at one point of intersection (*Mont Blanc*) so many, and at the other (*Leuk*) the warmest springs are met with. Moreover, many thousand springs present themselves, some in the glacier streams, some under the glaciers themselves, and some may be stopped up. Thus, most of the above mentioned thermal springs have been discovered only since Saussure's journeys; a few very lately, such as that at *Lavey* in the bed of *Rhone* in 1831; and others again have become filled up.

Among those which occur in the continuation of the principal Alpine chain, I will mention only the two most celebrated, *Pfeffers* and *Gastein.* They are distinguished by their very small proportion of solid and volatile ingredients. In fact they are scarcely any thing more than warm glacier-water.* It seems to me that these thermal springs, and probably many others also in the *Alps*, resemble exactly those in *Ischia*, which Daubeny supposes to be purely the result of the infiltration of water to spots in the interior of the earth retaining a high temperature, with this difference only, that these spots lie somewhat deeper in the

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* Of the thermal water of *Gastein*, 10,000 parts contain only 3.5 solid matter; the same quantity of water from the *Lüttschine*, which flows immediately out under the glacier, contains only one, and that from the *Aar* at *Bern* only, 2.2.

*Alps* than at *Ischia*, where the hot masses approach nearer to the surface in consequence of volcanic activity.

In regions where, after the earlier general elevations, later partial fractures and elevations have been produced by volcanic action, remarkable phenomena also present themselves, with regard to the existence of thermal springs; as for instance, in *Auvergne*, and in the vicinity of the *Laucher See*.

In regard to the former, it is worthy of remark, that the baths of *Mont-Dore* are situated almost at the geographical centre of that group of hills, and also at the position of greatest dislocation; two of the centres of elevation, which Elie de Beaumont and Dufrénoy have pointed out, being found on one side, and one on the other. The springs issue immediately from trachyte, which is most remarkably and beautifully columnar just at the baths. These column have an extremely slaty cleavage perpendicular to their axes.* Although the clay-slate rocks in the district of the *Laacher See* are very massive, and so far unfavorable to the penetration of meteoric water to great depths, yet the number of mineral springs here is very considerable. They belong, in general, to the class of thermal springs, although their temperature is for the most part but little (often only 1°.5) above the mean of the soil. The strata of these rocks are raised, and thereby produce a descent of the meteoric water to deeper points; nevertheless, springs of this kind are very rare, where no volcanic masses have been broken through. In these rocks slate-surfaces (Schieferungs Flächen) are often found, which do not coincide with the direction of the strata, but intersect them at an acute angle. These slate-surfaces give origin here and there to mineral springs, and a copious disengagement of carbonic acid gas.

By far the greater number of the mineral springs take their rise in valleys more or less deeply hollowed, on both sides of whose declivities, conical volcanic rocks, chiefly of a basaltic nature, have broken through. Some of them rise immediately from the clay-slate rocks, frequently from the cleavage surfaces which separate the strata of clay-slate and greywacke, and some come from volcanic masses (trass and volcanic ashes) which cover these rocks. The circumstance that these mineral springs seldom, perhaps

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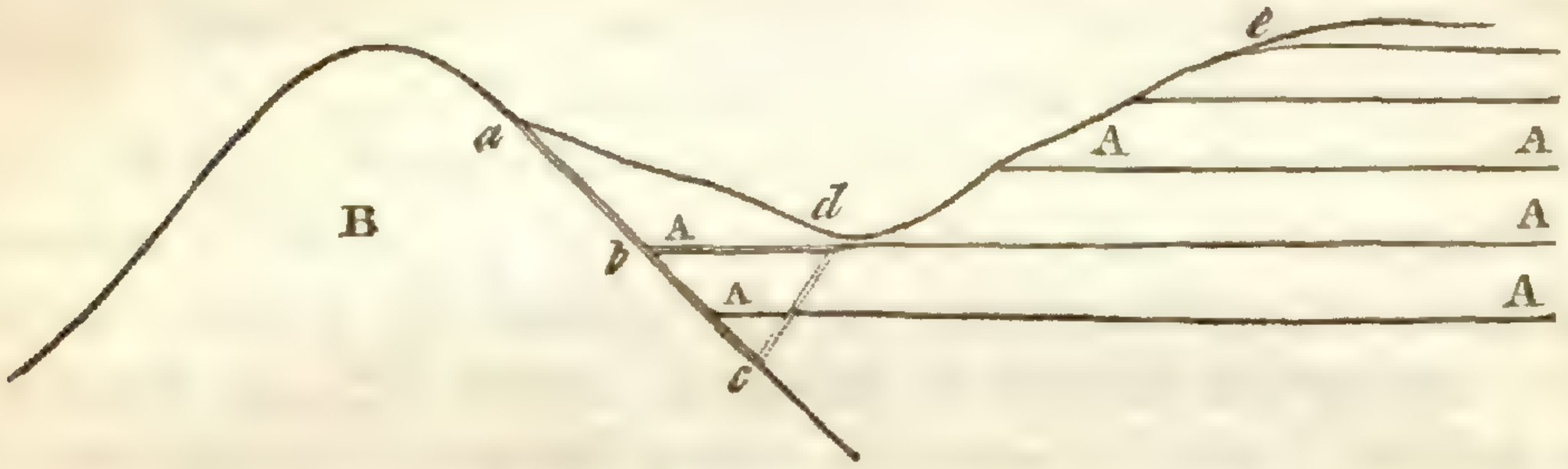
* Forbes, loco cit, p. 607.

never, flow out at the boundary between the erupted masses and the fundamental rocks, gives us an indication where to seek their origin. If the strata of the fundamental rocks, A, A, Fig. 2, are

**Fig. 2.**




inclined from the erupted volcanic mass B, then a cleft will be formed to a great depth in the interior of the earth at the boundary between this cone and the fundamental rocks, in consequence of the contraction of the former during its cooling. Down this cleft the meteoric water penetrates and meets the streams of carbonic acid gas developed in the interior. This latter is absorbed by the water, owing to the strong hydrostatic pressure exerted at so great a depth. This forms a water impregnated with carbonic acid, which effects a decomposition and solution of the stone, and hence arises an acidulous spring, rich in carbonic acid and carbonates. The deeper the meteoric water penetrates, the warmer it becomes. Rising springs of water are then produced in this cleft, through which the concentrated mineral water formed beneath at *c*, rises to *b*. If here the direction of the slaty or stratified surface (Schieferungs oder Schichtungs Fläche) leads down to *d*, which either has an immediate exit in the section of the valley *a b e*, or runs at a slight depth below the surface, then the mineral spring will issue, owing to the pressure of the column of water *a b*. While the rising streams of warm water take the course *c b d*, the originally concentrated mineral water becomes diluted by the fresh water flowing down from above; the carbonic acid gas, absorbed in great quantity beneath, is gradually disengaged as the water rises, and consequently the hydrostatic pressure is diminished, and thus free carbonic acid gas is evolved at *d* with the acidulous spring. It is clear, that the carbonic acid gas, which is constantly disengaged from the rising water during its whole course, not only moves on with the water on the surface of the stratum *b d*, but fills all the intervals

of the clefts in the whole clay-slate rocks so that the gas will be evolved wherever these clefts are open at the surface. If these fissures open above the bottom of the valley, and therefore are not filled with water, at least not up to the opening, then the gas will escape from them with a hissing noise. If, on the other hand, they open from beneath the bottom of the valley, and are therefore filled with water, then the gas will escape bubbling through the water, and present entirely the appearance of a mineral spring. If, lastly, these fissures be covered by alluvium, which, nevertheless, does not form an air-tight covering, then the gas will escape silently from the ground, and such places are recognized from the scanty vegetation which exists there. I know but one of the first description of fissures in that district, which is found close to the first mineral spring, called *Fehlenbor*, in the valley of *Burgbrohl*, between *Tönnisstein* and *Burgbrohl*. Such a fissure is also found in the *Eifel*, in the *Brudeldreis*, as it is called, not far from *Biresborn*. Fissures filled with water, from which gas is evolved, are tolerably numerous, as, for example in the valley of *Burgbrohl*. I formerly considered these spots (which are constantly met with in the vicinity of the brooks, and consist of little basins filled with water) to be actual mineral springs. If, however, the basin be emptied out, or the water drained off, it is at once perceived that no water springs up, but that merely an escape of gas takes place. I have had an opportunity of causing such gas-springs to be enclosed, and found the disengagement of carbonic acid gas to be extremely copious.* Fissures, covered by accumulated earth, are very frequently met with. If such a place presents a slight excavation, in which the gas collects, suffocated animals, as birds, mice, frogs, &c., are commonly found in it.

As springs run in the most different directions between the surfaces of strata, and through the fissures of the strata, so also do these disengaged gases. I have often had occasion to cause excavations to be made, in places where a scanty vegetation rendered the disengagement of carbonic acid gas at some depth probable. Fissures were often met with in the trass, out of which rose abundant streams of this gas. Sometimes natural canals in the trass were found under a covering of *Sphärosiderit*, which

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* Jahrb. der Chemie et Phys. t. lvi, p. 129. (1829.)

could be pursued from ten to twenty feet in a horizontal direction, or nearly so, and which doubtless were prolonged still farther.*

If the carbonic acid gas arises from below with considerable elasticity, and the cleft contracts very much from *b* to *c*, then it may easily happen that the meteoric water may penetrate but little below *b*. In this case, the column of water *a b*, will be as it were supported by the column of gas,† and at the point of contact, a constant absorption of the gas will be going on. In this manner, probably, are those mineral springs formed, which abound in carbonic acid gas, but contain very little solid matter, and whose average temperature exceeds but little that of the neighboring wells. It must frequently be the case, moreover, that many springs which rise from a greater depth, and therefore are originally warm, become cooled by mixture with cooler springs.

The warmest of the mineral springs in the environs of the *Laacher See* exceed the mean temperature of the ground by 7° to 10° Fahrenheit. What is worthy of remark is, that they rise from the deepest spots of the valley, where, therefore, their subterraneous channels are proportionably deepest under the rock, and possess already a relatively higher temperature. On pursuing the mineral springs up the valley, we find that their temperature decreases in a somewhat regular ratio.‡

The proportionably small number of clefts in the clay-slate rocks may certainly account for the circumstance, that, in the *Laacher See*, the *Eifel*, and the *Taunus*, so few springs of considerable high temperature occur, though the channels of the carbonic acid gas lead down to such great depths, probably to points where a red heat exists. Such warm springs may perhaps owe their existence to the favorable circumstance of a cleavage surface, which intersects the strata at an obtuse angle, leading up from the cleft between the volcanic cone and the clay-slate rock, and opening at a valley, as *c d*. Perhaps the warm springs at *Bertrich*

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* Neues Jahrbuch de Chem. et Phys. t. viii, p. 423, year 1833.

† The rising and falling of the periodic spring of the salt-work at *Kissingen*, is doubtless a consequence of the elasticity of carbonic acid gas. See Poggendorff's Ann. t xl, p. 495.

‡ So in the chain of *Taunus* mountains, the warm springs rise deep in the valley, the cold acidulous springs on the heights.

and *Ems*, which rise in deeply hollowed valleys in clay-slate rocks, are thus produced.

We may also easily conceive the possibility of obtaining a thermal spring by boring. A slight glance at the figure will show that a hole bored into a clay-slate rock in a valley, in the vicinity of a volcanic cone, will probably give exit to a thermal spring, if the borer reach the surface of a stratum or a slate surface communicating with the cleft between the volcanic and the clay-slate rock. A successful attempt of this kind was actually made a few years ago, by boring into the clay-slate rock at the foot of the basaltic hill, the *Landskrone* in the *Ahr* valley, about three German miles north of the *Laacher See*, when a copious mineral was obtained of the temperature of 58° F., affording considerable disengagement of carbonic acid gas. Indications prognosticating a favorable result of this undertaking were indeed present, inasmuch as a mineral spring already existed at the distance of but a few steps from the spot.*

Phenomena, perfectly resembling those which are observed where volcanic masses have actually broken through, present themselves very frequently. A cleavage, reaching to great depths, may also be a consequence of a preceding elevation and fracture of the component strata, without an actual breaking through having taken place. These phenomena are found in formations of all ages. Thus Hoffmann† has pointed out, in the north-west of *Germany*, some peculiar valleys which, originally perfectly closed, are surrounded on all sides by a precipitous escarpment, whose component strata incline from the centre downward, in every direction. He has given to these valleys the name of

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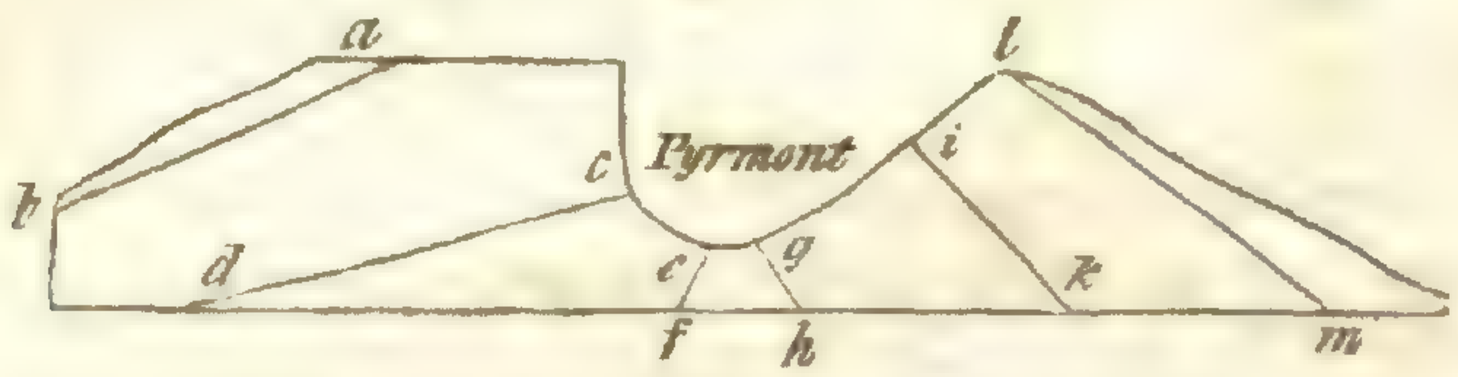
* A joint-stock company is also at this moment employed in boring into clay-slate rock at *Thal-Ehrenbreitstein*, near *Coblentz*, in order to procure thermal springs. Since this spot lies scarcely two German miles distant from the well-known hot springs of the temperature of 75° to 131° F. at *Ems*, and at a lower level, and since an acidulous spring already exists there, the possibility of the success of this undertaking is as little to be despaired of, as a favorable result can be promised. Leop. von Buch's remarks on this subject in Nöggeraths Ausflug nach Böh[illegible]en. Bonn. 1838, p. 5. The instance of the salt work of *Nauenheim*, near Friedberg, where a salt spring of 100° F. with immense disengagement of carbonic acid gas was obtained by boring, proves that success is more likely to attend by boring into secondary formations, where a more frequent alternation of various strata exists. At *Hofgeismar*, near *Cassel*, a new thermal spring with copious disengagement of carbonic acid gas was also obtained by boring, in May, 1834.

† Poggendorff's Ann. t. xvii, p. 151.

valleys of elevation. The most remarkable of these, are those of *Pyrmont*, *Meinberg*, and *Driburg*, where the well-known chalybeate springs rise, accompanied by a considerable disengagement of carbonic acid gas. *Pyrmont* and *Meinberg* lie precisely at those places where the directions of the northeastern system of mountains and of that of the *Rhine* intersect.

Here, therefore, we find also a considerable disengagement of carbonic acid gas; yet no volcanic masses which have broken through; but only the secondary strata of shell limestone, of keuper and variegated sandstone, raised up and fractured. The mineral springs are of another kind, and the alkaline carbonates are wanting, while sulphates and metallic chlorides supply their place. We may easily explain this by the absence of rocks containing alkalies; for instance, basalt or any other volcanic rocks. The clefts produced by these fractures reach certainly to great depths; carbonic acid gas may be evolved from them, but its elasticity seems to prevent the penetration of meteoric water. The mean temperature of the mineral springs there, exceeds, therefore, but little that of the place of their occurrence. This is especially the case with the mineral springs at *Meinberg*, whose considerable annual variations of temperature prove that they take their origin very near the surface. The considerable elasticity with which the carbonic acid gas escapes, and which is greater than I have observed at any place where gas is evolved, prevents, no doubt, the deep penetration of meteoric water. Moreover, we may remark, that the inclination of the strata, from the centre downwards in every direction, carries the meteoric water away from the seat of the evolution of the carbonic acid gas. Even supposing, then, that the water could penetrate to the depth of the channels of carbonic acid, it would not rise, owing to the

Fig. 3.




absence of the pressure of a column of water. The section of the valley of elevation of *Pyrmont*, taken from Hoffmann's work, Fig. 3, distinctly shows the inclination of the strata *a b*, *c d*, *e f*, *g h*, *i k*, *l m*, from the centre downwards.

It is possible that the raising and fracture of the secondary strata in such valleys of elevation, was the consequence of the elevation of volcanic masses from beneath, which masses have not appeared at the surface. Supposing this to be the case, we can easily imagine that at such places, mineral springs may be produced which contain carbonates of alkalies, because the meteoric water only can penetrate to these masses. But the low temperature of the acidulous springs in question, shows that meteoric water penetrates to very small depths only at these places.

Valleys of elevation of the kind described, seem to be of tolerably frequent occurrence; thermal springs and disengagements of carbonic acid gas are not, however, always met with, either for want of sufficient depth of the clefts, or for want of materials which give rise to the disengagement of carbonic acid gas. Instances of three of such valleys at the eastern end of the basin of *London*, are given by Buckland.* See also his and Conybeare's† description of the structure of the country at *St. Vincent's* rocks; and the example at *Matlock* long ago pointed out by Whitehurst.‡ Many other instances of this kind occur in Daubeny's report.‖ Stifft§ also has long ago shown, that the rocks in the neighborhood of the mineral springs of the *Nassau* territory manifest evident changes in the direction and inclination of their strata, especially saddle-shaped elevations, often accompanied with fractures.

Finally, dislocations or faults produced by elevations and intersecting stratified rocks, may direct the subterranean course of springs in a very different manner. Buckland¶ has given many instances of springs originating from causes of this kind.

If we take a summary view of all that has been said on the subject of thermal springs, we shall find it impossible to avoid recognizing a relation between elevations of Plutonic masses, the upraising of Neptunian formations, and thermal springs. Cause and effect have, however, been frequently confounded here. Thermal and mineral springs are seldom, perhaps never, the cause of those effects. Where, however, these effects are observed,

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* Geological Transact. sec. ser. vol. ii, part i, p. 119. † Ibid. vol. i.
‡ Theory of the Earth, 1786. ‖ P. 66.
§ Rullmann Wiesbaden, &c. 1823. p. 103.
¶ Geology and Mineralogy, &c. London, 1836, Vol. ii, p. 106 and 110.

where, in consequence, the penetration of meteoric water into the interior of our earth has been rendered possible, and where natural hydraulic tubes have been formed by the upraising of strata, there the phenomena of thermal and mineral springs were the consequence.

We should transgress our limits, were we here to pursue the subject of thermal springs in their chemical relations, since the general aim of these remarks is to show that their degree of heat depends on the greater or less depth of their origin, consequently wholly and solely on central heat. The following remarks, however, upon their chemical constitution, may perhaps not be entirely superfluous.

The chemical ingredients of those springs which take their origin at the boundary between volcanic and Neptunian formations, are derived in some springs from the former, in others from the latter formations, in others again from both. The following conjecture is probable. If considerable quantities of carbonic acid gas are disengaged from the interior, which are absorbed under strong hydrostatic pressure by the water, and thus act on the volcanic stone, decompositions ensue. The alkalies which are found in all stony masses of igneous origin, are extracted by the carbonic acid, and taken up by the water as carbonate of alkalies, and especially carbonate of soda. In the same manner are formed the bicarbonates of lime, magnesia, and of protoxide of iron. Metallic chlorides and sulphates may perhaps be less frequently derived from volcanic matter, and more so from the Neptunian formations. In this matter probably, are formed the great number of springs, which rise in the neighborhood of basaltic hills. Where there is no disengagement of carbonic acid gas from the interior, no such mineral springs are found; at least we cannot assume that in this case the volcanic rock contributes any thing essential to the constituents of the springs. Thus, probably, neither in the *Pyrenées* nor *Alps* do the springs take up any thing essential from these rocks. The circumstance, that springs of very various chemical composition arise in the vicinity of the granite of different mountains, might here serves as an indirect proof. At the same time, the nearly similar composition of the springs occurring in the neighborhood of the basaltic cones, where carbonic acid gas is disengaged, however different may

be the Neptunian formations, is an argument in favor of these springs deriving their ingredients principally from the basalt.

The organic matter found in such abundance in the sulphureous springs of the *Pyrenées* (baregine, glairine, animal matter) proves, that their chemical constituents must be derived, at least in part, from the Neptunian formations. Since no carbonic acid escapes from the rocks there, the granite in the interior may, indeed, suffer but slight decompositions. The formation of the sulphureous springs there, probably by the decomposition of sulphates by organic matter, is certainly much favored by the high temperature of these springs; and this again is a consequence of the great depth to which the clefts extend in the strata, which are piled up one on another in considerable masses, and partly raised up, with many strata-surfaces between them. The coincidence of various circumstances may thus produce one class of thermal springs in preference to another.

In the *Alps*, where, on account of the absence of escapes of carbonic acid gas, decomposition of the granite and other volcanic rocks does not take place, and where even the Neptunian formations contain few soluble substances, we find thermal springs, which are scarcely any thing more than ordinary warm water.

On the other hand, we see thermal springs issuing, to all appearance, from erupted masses, which springs contain ingredients apparently peculiar to those which can be proved to issue from Neptunian formations. This is, for instance the case with the salt-spring, which rises at *Kreuznach* out of porphyry. This rock is but little fissured, and yet the high temperature of the springs, 58° to 83°, indicates a deep origin. Since the porphyry has penetrated the variegated sandstone, the latter, and also the shelly limestone, lie in close contact with the springs, so that this volcanic rock has no other share in the formation of these springs, than the production of deep clefts between itself and the Neptunian formations, which have permitted meteoric water to penetrate into the strata containing the salts. We must not pass over one circumstance, which induces us to attribute to these saline springs a totally distinct origin, viz., that sulphate of lime, which otherwise so generally accompanies the common salt, is here entirely absent, and that these springs are remarkable for their abundance of bromine and iodine.

As escapes of steam (fumaroles) show themselves in regions (Tuscany for example) where hot masses have approached the surface of the earth by volcanic activity, one might perhaps be induced to expect evolutions of steam from clefts penetrating deep into the interior. It must, however, be observed, that between these two cases a wide difference exists. In regions where volcanic action still manifests itself, clefts can with ease extend in masses which are of a boiling heat or even hotter. Meteoric water penetrating these clefts will be converted into vapor and exhaled. Were, however, such a phenomenon to show itself in regions where the increase of temperature follows the progression, which we have found it to do in accessible depths, then must such clefts extend perpendicularly to a depth of about 8280 feet in our country. But are any rocks, even the unstratified masses, traversed by continuous clefts of so great a depth? In granite the prismatic separation is very frequent. The columnar structure is most distinct in basalt, aphanite, and all dense and homogeneous rocks. The columns are sometimes traversed and disjointed by traverse clefts. The surfaces of separation (Absonderungs Flächen) in the smaller masses, always lie perpendicularly on the adjacent ones, as do also the columns, when present. Let us assume that such a jointed separation extends to the requisite depth, and that meteoric water penetrates so far, and then it will certainly rise converted into steam; when, however, it attains the higher colder regions, it will become condensed again, and resume the same course or circulation.

Since the volcanic masses, when thrown up, form, generally, the greatest heights, we must look in them for the compressing columns of water, which render the rising of the springs possible. The possibility of such a case is conceivable, when the surface of the unstratified rock is inclined in one or more directions, and the columnar separations are jointed by transverse clefts. It is, however, even then, possible only when the transverse clefts have no continuation outwards, for in this case the water will take a side course, and either issue on the slope of the rocks as springs, or, if raised strata exist, it will take the course designated in the preceding remarks. These two last cases seem to be the most usual, as the circumstances above explained, prove, viz., that thermal springs most frequently present themselves between the unstratified and stratified rocks. I have imagined the

last case, in order to exhibit the possibility of hot springs rising in the *Alps*, when water descends from great heights to the interior of the rocks, flows through warmer strata of earth, and then makes its exit in the valleys. It is clear that such springs merely flow from above downwards, when the raised strata make their appearance externally, but that they will, on the other hand, rise again, if the strata are upraised in the form of a trough on the opposite side.

Phenomena lately observed, may perhaps present cases, where the effect of the internal heat of the earth nearly approaches the surface. Marcel de Serres,* for instance, describes a cave near *Montpellier*, situated in the Jura limestone, in which, at depths of 135 and 150 feet, a constant temperature of 72°.5 F. prevails, which exceeds by 10° the mean temperature of *Montpellier* (62°.5.) He shows that no accidental circumstance, such as decompositions, the burning of tapers, or the respiration of those who visit the cave, can be the case of this phenomenon; but believes it is to be sought for in the central heat, which rises through clefts and affects one point more, another adjacent one less. Thus, at the distance of about 1200 feet from this cave is found a cleft in the same formation, from which issue watery vapors, whose temperature, 73°.5 (that of the external air being 52°–54°.5,) is nearly the same as of an artesian well close in the vicinity of the cave (70°.–72°.) These vapors, which probably rise from thermal springs existing beneath, are constantly disengaged, and maintain a temperature of 73°.5, though in constant contact with the external air. The cleft from which they issue, communicates with other wider clefts, which expand into caves, into which the inhabitants of the estate of *Astier* have already penetrated. The laborers on this estate are in the habit of warming themselves pretty frequently in the hole where these vapors are formed. On examinations, this vapor has all the purity of distilled water. At an earlier period there existed, at the distance of 150 to 180 feet N.E. of the grotto of *Astier*, another opening from which an equally warm vapor was evolved, which could be perceived at some distance off. This opening has, however, been since filled up. This constant vaporization of water, in the middle of the same rock in which the cave

* Des Cavernes chaudes des environs de Montpellier in Annal. de Chim. et de Phys. t. lxv, p. 280.

is found, shows pretty evidently the cause of the warmth in the latter.

It is scarcely to be doubted, but that, on closer investigation, the phenomenon of local heat in caves in the limestone rocks, which are fissured to such great depths, would be found to be of more frequent occurrence. The spring of the *Orbe* in the Jura mountain, formerly mentioned, which is nothing more than the discharge of the lakes situated 680 feet higher in the valley of the *Joux*, proves among others, to what a depth the clefts in the limestone rocks descend.

The whole ridge of the chalk hill of the *Teutoburger Wald* near *Paderborn*, is fissured to depths exceeding 800 feet, so that, on this whole ridge, either no springs at all, or but a few very scanty ones, are met with, which probably owe their existence to partial beds of marl in the chalk rocks. In three villages which lie on this ridge, there is but one well 80 feet deep. On account of this almost total want of water, these are called the "Dry Villages." The cleavage continues in the valleys, which traverse these hills, consequently the brooks and rivers which flow through them gradually sink and flow out of the openings of these valleys only in the wet season of the year. At the foot of these chalk hills on the other hand, where the fissured limestone is covered by a stratum of marl, a very great number of copious springs issue, several of which form considerable rivers, as the *Lippe*, *Pader*, *Heder*, &c., immediately after their exit. The cleavage of the chalk rocks is doubtless continued in the *Quader Sandstein*, which lie below and probably is limited by the lias (*gryphitenkalk*) and veriegated marl, which follow immediately below the green sand, and which are remarkable for their large strata of clay marl (*thonmergel*,) that are impermeable, unless broken or dislocated by elevations. This whole chain of hills, then, from the clay-marl strata to the level of the springs which issue on the western declivity of the *Teutoburger Wald*, is, therefore, saturated with water like a sponge. Not merely geognostical reasons, but also physical relations, furnish incontestible proofs of the existence of these considerable subterraneous reservoirs of water. For instance, while the water of the above-mentioned sinking brooks and rivers penetrates into the interior of the hills with the variable temperature of the seasons, the waters of the numerous springs of *Paderborn*, whose

mean temperatute is 50°.6 F, and exceeds the mean temperature of the soil by about 1°.7, present already a uniform degree of heat. Thus, on the 21st May, 1834, I found the temperature of the *Alme* at *Brenken*, where considerable masses of the water of this river flow down through the clefts of the chalk, to be 63°, while the springs at *Geseke*, at the distance of 22,000 feet, which doubtless receive their supply from this river, were of the temperature of 49° to 51°. The miller there, whose mill is turned by one of these springs (what is called the *Völmeder* spring,) told me he had often opened the holes found on the banks of the *Alme*, and let in as much water as would have been alone sufficient to turn his mill, but that he never perceived the slightest increase of the streams. This also proves the great extent of the subterraneous reservoir of water, whose discharges are not perceptibly increased by an addition of water. If, indeed, these additions are continued by continued wet weather, and the level of the subterraneous reservoir rises, then, not only will those springs become more copious, but water will also issue from high situated channels, which contained no water during the dry season. Lastly, the same miller assured me that the muddiness of his mill streams by no means depended on that of the *Alme*, since they always become so after rain. Opinions were, however, divided on this point, as other inhabitants of *Geseke* maintained, that, within twelve or sixteen hours after rain, the *Alme* became mudy, and the *Völmeder* springs became so too, while this had no influence on the springs in the town. Be this as it will, thus much is certain, that all the springs there do not become muddy after rain, but that many always remain clear, as the warmer among the *Pader* springs. This circumstance is also a satisfactory proof of the great extent of the subterraneous reservoir, because, notwithstanding the fact, that the sinking rivers and brooks, as well as the rain-water and snow-water, which penetrate into the fissures of the fissured rock, are all muddy in rainy weather, yet the warmer springs, those consequently which rise from a greater depth, run out clear.

I have instituted some experiments in order to ascertain what must be the extent of a single mass of water, which retains a uniform temperature, when a given quantity of water is added to it, whose temperature varies with the variable temperature of the rivers of our latitude, and when from it is discharged an equal

quantity of water, whose annual variations of temperature are limited to those observed in the coldest of the *Pader* springs.* The water district (Wassergebiet) of these springs is about 216 millions of square feet, and the quantity of water which they afford in one minute 16,530 cubic feet, according to measurements, as accurate as the nature of the thing would admit. It was calculated, from these numerical data, that a mass of water, 120 feet in depth, must be present in this district where the springs rise, if all the water which sinks here in half a year produce an alteration of temperature of 2°.25 F., presupposing that a mean differance of 22°.5 exists between the temperature of the water which sinks, and of that which lies in the fissured rock. Since, however, the presupposition that *all* the springs in *Paderborn* undergo this variation of temperature of 2°.25 in a half year, applies only to those whose average temperature does not exceed 50°.6 F.; while the warmer springs, which are by far the more numerous, exhibit no variation of temperature during the whole year; the size of the subterraneous reservoir must be much vaster, if such *considerable* quantities of water of a *uniform* temperature flow from it, while the water which sinks and is added to it, suffers variations of temperature dependent on those of the atmosphere.

Calculations of this kind can, from the nature of the subject, give but approximations to the real size of that of which we could otherwise form no estimate at all. The preceding calculation shows, at least, that all the clefts and caverns in the chalk rock of the *Teutoburger Wald* must be filled with water from the level of the springs, down to some impermeable stratum. How otherwise can we explain the fact, that considerable quantities of water of the varying temperature of the atmosphere constantly sink into the rock, and that as considerable quantities flow out at the slope of the rock, presenting a uniform tempera-

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* It is really a remarkable fact to see so considerable a number of springs rise in so small a compass as the lower part of the town of *Paderborn*. Their number is said to amount to 130, several of which constantly appear close together, often at the distance of but one or two paces, and immediately form considerable brooks, which by their union form the *Pader*, so large a river, that its different branches turn no less than fourteen undershot water-wheels of the town situated near together. Almost equally large masses of water, however, derive their sources from *Lippspring*, *Kirchborchen*, and *Upsprung*, not to mention the many other springs which lie dispersed at the foot of that chain of hills.

ture, or at all events, one which varies only 4°.5 Fahr., in a whole year. Since the conjecture is probable that the lias and the variegated marl present the first entirely impermeable strata, we may also conclude, that not only the chalk formation, but also the green sand, which is equally fissured, are filled by the reservoir, and that its bottom is formed by the above mentioned impermeable strata. Lastly, the high temperature of what are called the warm Pader springs (54°.5–61°.25 Fahr.) indicates also an origin from a greater depth, if they do not flow in distinct channels, but come from warm streams, which rise from the base of the reservoir.

The copious springs, which rise on the western declivity of the *Teutoburger Wald*, owe their abundance of water, even in dry seasons, to these vast subterraneous reservoirs; and what is derived from these reservoirs, is abundantly replaced in the rainy reasons, when nearly all the water collected in a district so much fissured, penetrates into the interior.

These large masses of water, whose temperature exceeds, by several degrees the average one of the district under which they are collected, and which brings so much the more heat to their surface the deeper they penetrate, have doubtless the effect of warming the hills under which they exist. It is therefore perhaps a phenomena of universal occurrence, that all chalk hills, which are much fissured, and into which brooks, rivers, and most of the meteoric water sink, maintain a relatively higher temperature. The *Pader* springs alone, however, show how inexhaustible must be the sources which warm such vast masses of water. These springs furnish in a year at least 8688 millions of cubic feet of water, whose average temperature exceeds by at least 6°.75 Fahr., the average temperature of the ground at *Paderborn*, and this excess would melt a cube of ice, having a side of 934 feet. This heat is irrevocably withdrawn from the interior, and yet the thermal springs of *Paderborn* have sustained no diminution of heat from time immemorial.* Chemical processes, which could there give rise to such inexhaustible sources of heat in the youngest secondary formations, must be, or have been, carried on to a great extent indeed!

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* By far the greater number of the remaining copious springs, which rise on the western declivity of the *Tutoburger Wald*, are also thermal ones. Some, for instance, in *Lippspring* attain a temperature of 54°.5.

ART. V.—*Reply of* Dr. DAUBENY *to Prof. Bischof's Objections to the Chemical Theory of Volcanos.*—Edinb. New Phil. Jour. for April, 1839.

Prof. DAUBENY after referring to an article of his in the Edinb. Jour. for 1832, and to the article Volcanic Geology, in the Encyclop. Metro., proceeds to vindicate his own views in regard to the chemical theory of volcanos, by replying as follows, to the objections against it.

1*st Objection.*–It is not true that volcanos are always near the sea.

Pesckan, in the centre of Asia, is 260 geographical miles from any great sea, and yet has given rise to streams of lava within the period of our history. It also lies 25 geographical miles from the lake of Timartu or Issikul, which is not twice as large as the lake of Geneva.

The volcano of Turfan also is surrounded by very inconsiderable lakes.

*Answer.*—The general connection of volcanic action with, or a proximity to, large masses of salt or fresh water, is all that seems required by the conditions of our theory.

Now, in proof of this general proximity, it may be remarked, that out of a catalogue of no less than 163 active vents enumerated by M. Arago, as occurring in various parts of the known world, all excepting two or three in different parts of America, and about the same number of which we possess very imperfect information, in Central Asia, are within a short distance at least of the ocean. It is even found that the very excepted cases, when examined, tend to confirm the rule, being so situated, that their connection, either with the ocean or with inland seas that may supply its place, becomes a matter of fair inference. In proof of this, we need only refer to the descriptions given by Humboldt of Jorullo; from which it appears, that distant as this mountain may be both from the Atlantic and Pacific Oceans, it is nevertheless connected with one or both through the medium of a chain of volcanic eminences; and even the volcanos of Tartary, whose existence in an active condition is more problematical, may be connected with some of those extensive salt lakes which seem to abound in the depressed portion of Central Asia.

*2d Objection.*—Atmospheric air cannot gain admittance to the focus of a volcano, because there must be an enormous force *act-*

*ing outwards* to protrude the liquid lava to so great a height, and as this pressure continues for *many years*, during which time the phenomena by no means abate in activity, it is impossible that air should in any way contribute to it.

*Answer.*—The very conditions of our theory imply the existence near and about the focus of the volcano of vast caverns, caused originally by the heaving up of the softened rocks, owing to the elastic vapors disengaged, and consequently filled in the first instance by these matters. But the amount of these vapors must be undergoing continual oscillation. 1st, Owing to differences of temperature caused by the constantly varying intensity of the volcanic action. 2dly, By the reaction of the gases upon each other, as for instance, sulphuretted hydrogen upon sulphurous acid, muriatic and carbonic acids upon ammonia, the fixed alkalies and the earths. 3dly, By the ever-varying proportion between the amount of water decomposed by the alkaline or earthy metals, and generated by the union of hydrogen to the oxygen present. Hence, unless the passages between these caverns and the external atmosphere were hermetically sealed (which no one contends), air must at times enter the latter to fill the vacuum thus occasioned.

3*d Objection.*—If the oxidation of the earthy and alkaline metals were to take place at the expense of water, enormous quantities of hydrogen would be evolved, which has never been observed.

*Answer.*—Hydrogen could hardly be expected to escape in a free state from a spot which contained so many elements for which it possesses a strong affinity, and to which it would be presented under the influence of the pressure and temperature so well calculated to promote its combination with them.

Thus, sulphur and chlorine we *know* to be generally present in volcanos, and oxygen and nitrogen, we may fairly *assume* to be so. But, although hydrogen may not be disengaged alone, large quantities of it, in combination with sulphur, appear to be almost universally evolved from volcanos, and it is probable that the great beds of sulphur which exist in most volcanic districts (viz. Sicily) are the result of the decomposition of the sulphuretted hydrogen evolved. Nor, indeed, does it seem possible to explain the presence of this hydrogen, without having recourse to the chemical theory.

*4th Objection.*—The evolution of carbonic acid by volcanos is not explained, and these disengagements of carbonic acid gas could not take place in the presence of atmospheric air in those vast subterranean cavities without their mixing together. Now, the carbonic acid evolved by volcanos (Vesuvius, Eifel, &c.,) contains but little atmospheric air.

*Answer.*—The evolution of carbonic acid in countries exposed to the influence of volcanic heat, would seem to be a necessary result of the existence of calcareous matter in the rock formations. Its continuance for so long a period after the volcano has ceased to be in activity, seems to show, that it is not derived directly from the chemical processes which produce the phenomena in question, but is only caused by the heat which these processes tend to diffuse through the adjacent rocks. Hence there seems no reason why it should be intermixed with any large proportion of common air, though, as I have shown, this ingredient is rarely altogether absent in any samples which it has fallen to my lot to examine.

*5th Objection.*—No nitrogen, according to Boussingault, is evolved from the volcanos under the equator, as would be the case if any process of oxydation were going on in which atmospheric air co-operated.

*Answer.*—The nitrogen remaining after the atmospheric air had been robbed of its oxygen, by the inflammable bodies present, may reach the air either in a separate condition, or united with hydrogen in the form of ammonia. The former I have generally found to be the case in thermal springs connected with volcanos in an extinct or languid condition—the latter in the craters or fumaroles of those still in a state of greater or less activity. I do not wonder, therefore, that Boussingault should have rarely detected nitrogen in the volcanos of the equator,* but I should expect that sal-ammoniac may, nevertheless, be exhaled from some of them. If this be not the case, it is still possible that the sal-ammoniac sublimed may have been accumulated within some of the vast cavities existing in the interior of the volcano, so that the occasional absence of nitrogen seems less difficult of explanation in accordance with the chemical theory,

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* In two instances it was present.

than the frequent associations of it with volcanos is, if we do not have recourse to this hypothesis.

6*th Objection.*—The metals of the earths are not sufficiently oxidizable to kindle on the access of water, and to produce the intense heat which would be necessary for producing and liquefying lavas.

*Answer.*—Silicon, though when pure it is incapable of decomposing water, and is incombustible in oxygen, yet kindles readily when united either with a little hydrogen or with alkaline carbonates. Aluminium, even by itself, burns brilliantly when heated above redness, and dissolves with the evolution of hydrogen in very dilute solutions of potassa.

Calcium and magnesium appear to be still more inflammable, and the bases of the alkalies, present along, and perhaps in combination with them, might, whenever water obtained access, generate heat sufficient to cause the other bases to enter into combination with oxygen. Besides, we know that aluminium and magnesium enter readily, with an evolution of heat and light, into combination with chlorine, a body which (as we shall see) there is good reason for supposing present in volcanos.

7*th Objection.*—The slight specific gravity of the metals of the alkalies proves fatal to Davy's hypothesis, for, if the mean density of the earth surpass that of all kinds of rocks, these metals cannot exist, at least not in great quantities, in the interior of the earth.

In reply to this I cannot do better than extract the remarks which I made in reply to the self same objection in my article on volcanos, published in the Encyclopædia Metropolitana in the year 1833.

"An objection against our hypothesis has also been sometimes deduced from the mean density of the Earth, which is calculated at five times that of water; and hence it has been concluded, that bodies so light as potassium and sodium are, cannot make a part of its nucleus.

But we are not obliged to imagine a larger proportion of these alkaline bases to be present, than would be implied by the composition of the lava emitted, and probably we shall find not more than four or five per cent. of potassa or soda to exist, in the average of volcanic productions.

On the other hand, the specific gravity of the basis of silica, and probably, also, of that of the other earths which predominate in lava, is sufficiently considerable to warrant the conclusion, that a mass of matter, containing these principles in the proportions indicated, and united with as much metallic iron as we know to exist in the state of an oxide in the generality of lavas, would form an aggregate pos-

sessing a higher specific gravity than that of the compound resulting from the oxidation of the entire mass.

Let us take for instance, the analysis given by Dr. Kennedy, of the lava from Etna, which he states to consist of

| | | | |
|---|---|---|---|
| Silica, | 52 per cent | × Sp. gr. 2.65 = | 127.8 |
| Alumina, | 19 per cent | × Sp. gr. 4.20 = | 79.8 |
| Lime, | 10 per cent | × Sp. gr. 3.00 = | 30.0 |
| Oxide of Iron, | 15 per cent | × Sp. gr. 5.00 = | 75.0 |
| Soda, | 4 per cent | × Sp. gr. 2.00 = | 8.0 |
| | 100 | | 320.6 |

We here find that 100 parts of this lava have a specific gravity equal to 320.6, and consequently that the specific gravity of the mass would be no more than 3.2, supposing it divested of water.

Now, let us contrast this with the specific gravity of 100 parts of the metallic principles, which would give rise to a mineral possessing the above chemical composition.

| | | | |
|---|---|---|---|
| Silica, | 52, contains of base, 26 | × Sp gr. 2.0 = | 52 0 |
| Alumina, | 19, contains of base, 10 | × Sp. gr 2.0 = | 20.0 |
| Lime, | 10, contains of base, 7 | × Sp. gr. 4.0 = | 28 0 |
| Oxide of Iron, | 15, contains of base, 12 | × Sp. gr 7.8 = | 93 6 |
| Soda, | 4, contains of base, 3 | × Sp. gr. 1.0 = | 3.0 |
| | 100 | 58 | 196.6 |

Now as 58—196—100—340.

Consequently the specific gravity of the whole would be no less than 3 4. The specific gravity of aluminium appears not to be ascertained, but probably it is not inferior to that of silicon, which sinks in the strongest sulphuric acid, and therefore is more than 1.83

The theory, therefore, we have been advocating, leaves the question, with respect to the cause of the Earth's density, just on the same footing as before. Those who are of opinion, that the latter may be explained by the mere condensation of such rocks as are found near the surface, in consequence of the superincumbent weight, as certain metals may be rendered heavier by pressure, are entitled to extend this explanation to the case of the alkaline and earthy bases; whilst those who regard the density of the Earth to be a proof that some heavier matter must exist below, are not precluded from such a supposition, as our theory implies merely the existence of such a quantity of metallic ingredients, as would be sufficient to produce the materials ejected, leaving the constitution of the remainder just as open to conjecture as it was before.

It is curious indeed, that whilst some have argued that the kind of materials found near the surface is inadequate to account for the density attributed to the Earth in general; others, as the late distinguished Professor Leslie, have contended, that these substances would have their specific gravity so much increased by the enormous pressure from above, that void internal spaces must be necessarily supposed. On this he has founded his singular hypothesis, that the centre of the Earth is filled only with light, the rarest substance known; an idea, the mere mention of which is sufficient to show how little we can be justified in rejecting an explanation of facts, merely because it appears to militate against the conjectures that may be conjured up with regard to the internal condition of our planet."

8*th Objection.*—If, according to Gay-Lussac, the hydrogen of the decomposed water goes to form muriatic acid with chlorine, the above mentioned acid ought to be general in volcanos. Now, it is wanting, according to Boussingault, in the volcanos under the equator in the New World, and according to Bischof, in those near the Rhine.

*Answer.*—I believe, that muriatic acid will be found pretty constantly present in volcanos now in activity. Sir H. Davy found it at Vesuvius on both the occasions he visited that volcano, viz. 1815 and 1829. I myself in 1834, detected it there in great abundance; and in 1825, found it at the Solfatara, in the Island of Vulcano, and near Mount Etna. It has been discovered also in the volcanos of Iceland; in those of Java, at Mount Idienne; and of South America, at Puracè. The sal-ammonia which so abounds in the volcanos of Tartary, shows, that it is also present there; and the existence of it in the trachytic rock of the Puy de Sarcouy in Auvergne, proves, that it was a concomitant of volcanic action in days that have gone by.

All therefore that Bischof is warranted in inferring from its absence in the case of the volcanos of the Rhine and Equatorial America, is, that it ceases to be disengaged when the action becomes languid or extinct. Now there are many ways of accounting for this. In the first place, granting the acid to be derived from the sea-salt present in the water which originated the volcanic action, it would cease to be generated when this fluid no longer obtained admission; or, when the heat was inadequate to cause the union of the alkali of the sea-salt with the earths present; and even if it were still generated, it might be prevented from rising to the mouth of the crater, by combining in its way with the calcareous rocks through which it had to pass. Hence the carbonic acid, which Professor Bischof remarks as so abundantly evolved by the volcanos of the Rhine, may perhaps represent an equal volume of muriatic acid, by whose agency it had been evolved from the limestones that contained it.

Thus have I replied *seriatim* to all the objections, which an acute and learned opponent has been able to adduce against the chemical theory of volcanos; and having done so, might be expected perhaps to proceed to some remarks on the one to which he himself has given the preference.

But in order not to occupy too much of your space, I will merely here remark, that Professor Bischof appears (at least in the portion of his memoir yet published) to pass over without any attempt at explanation, certain chemical phenomena of constant occurrence, which follow directly from the principles of the theory to which he has objected.

These are, 1st, The evolution of sulphuretted hydrogen, in quantities far exceeding what are to be explained by the reaction of carbonaceous matter upon sulphates, or any of those other processes which sometimes produce it on the surface of the earth.

2dly, The disengagement of sal-ammoniac, for although one of the constituents of this compound, the muriatic acid, might arise from the decomposition of sea-salt by aqueous vapor, the other one, the ammonia, implies the presence of free hydrogen as well as of nitrogen gas, near the focus of the volcanic action.

3dly, The circumstance, which I have substantiated in so many cases, that I begin to believe it almost universally true, that the atmospheric air exhaled from volcanos, and indeed generally from the interior of the earth, is deprived in a greater or less degree of its proper proportion of oxygen. That processes, therefore, by which this principle is abstracted, are going on extensively within the globe cannot be denied, and hence I conceive that any theory, which attempts to account for volcanic action, without taking notice of so essential a phenomenon, ought to be regarded as imperfect and unsatisfactory.

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## Art. VI.—*Mountains in New York;* by E. F. Johnson, Civil Engineer.

In a report recently made, by the author of this article, of a survey of a route for the proposed Ogdensburgh and Champlain railway, the elevations above tide of the highest of each of the three distinct groups of mountains divided by the valleys of the Saranac and Au Sable rivers, are given as follows:

| | |
|---|---|
| Lyon Mountain, | 3,864 feet. |
| Whiteface do. | 4,666 " |
| Mt. Marcy, | 4,907 " |

To this statement of elevations, the following note was appended:

"The altitudes here given, were deduced from the angular elevations observed from a point near Lake Champlain, whose elevation was known, and the distances as determined from the map. I mention this to account in part, perhaps, for the discrepancy between the results above given and those contained in the geological report as derived from barometrical measurement."

Prof. Emmons, State Geologist for the Northern District of New York, in his last annual report, in reference to the above, has the following:

"In a report to the Legislature this present session, Mr. E. F. Johnson, the Engineer of the Ogdensburgh and Champlain railroad, questions the accuracy of the measurements of Mt. Marcy. In reply to his suggestions, I shall merely remark, that it is quite doubtful whether the mountain in question is distinguishable from those of the same group, especially by one who has never visited the interior of this section, and if visible, his measurement is not entitled to consideration except as a very imperfect approximation."

The observations made by myself were taken, as stated, from an elevated point near Lake Champlain.

The instrument used was of a superior kind, and, graduated, so as to give, with the aid of the nonius, fractions of degrees as small as $7\frac{1}{2}$ seconds. On the day when the observations were made it was carefully adjusted.

Not only the peaks above mentioned, but the elevations of from 30 to 40 other points were observed, several of which had been previously measured. Among the latter number were the two most elevated peaks of the Green Mountains, Camels Hump and Mansfield; these were found, the former to be 4,220 and the latter 4,359 feet above tide.

These peaks, as measured barometrically by Capt. A. Partridge, (see Gazetteer of Vermont,) were found, the former to be 4,188 and the latter 4,279 feet above tide; *less* in both cases than the results by trigonometrical measurement. The barometrical elevations of Mt. Marcy and Whiteface, as given by Mr. Emmons, were on the contrary *greater* than the trigonometrical; the former by 687 and the latter by 189 feet; the first being 5,594 and the second 4,855 feet above tide.

It was this great discrepancy, that induced the remark of distrust, as to the entire correctness of Mr. Emmon's barometrical

measurement; a discrepancy which cannot be attributed to any inaccuracy of adjustment in the instrument used by me, since if by any error in this respect, the angle of elevation was too great or too small in one case, it was also too great or too small in the other, producing a corresponding elevation or depression in both. Neither can it be attributed to a difference in the estimated allowance for refraction, for this allowance was the same in both cases; hence if too great or too small, the elevations of both were similarly affected and to the same amount. The observations were also made from the same spot at nearly the same time of the same day; hence there could probably be no great difference in the refractive power of the atmosphere.

Again, so great a difference could not well result from an error in the distances, for although these were obtained as stated from the map, they were tested by comparing with known distances upon the same map, the latter having been projected on a large scale and compiled from actual surveys, with the positions of the several peaks, as is believed very accurately defined, that of Mt. Marcy in particular, coinciding *very nearly* with the location and bearing of it from Whiteface and other points, as described by Mr. Emmons. That some other peak was taken for Mt. Marcy, as is intimated by Mr. Emmons, is therefore scarcely possible, more especially as it is *certain* that the one observed was the *highest* of the group in which Mt. Marcy is situated. Had the peak in question been a *lower* instead of the *highest* one of the group, its not being "distinguishable" could be urged by Mr. Emmons with more propriety.

Assuming therefore, as is proper to do under these circumstances, that the trigonometrical measurement exhibits very nearly the *relative* elevations of the high peaks in Vermont and New York, it follows, that to place Mr. Emmons's barometrical measurements of Whiteface and Mt. Marcy upon a *par*, as it regards accuracy, with the barometrical measurements of Camels Hump and Mansfield, that the former should be reduced, the first about 290 and the second about 800 feet; or in other words, these are the differences in the barometrical measurements by the two observers. Both surely cannot be correct; and it is equally certain also, that both may be incorrect. Until, therefore, Mr. Emmons shall have proved, that his measurements are entitled to a higher degree of confidence, he must submit to have their accuracy ques-

tioned. It is granted that it is possible he may be after all nearest the truth, but so long as the evidence in the case is more against than for such a conclusion, his claim to *superior* accuracy cannot be allowed. Capt. Partridge has had perhaps more experience than any other individual in the United States in measuring mountain elevations with the barometer. In two measurements made by him of Mt. Washington in New Hampshire, the first gave 6,103 feet and the second 6,234 feet. The measurement of the same mountains by Prof. Bigelow, as computed by Prof. Farrar of Cambridge, gave as the height above tide 6,225 feet, a coincidence somewhat remarkable, considering the very great elevation of Mt. Washington.

Mr. Emmons states that the distance from Mt. Marcy to Whiteface is about 16 miles, and that the depression of the latter from the former is 15 minutes of a degree. If the instrument used by Mr. Emmons in taking this angular depression was a suitable one and in a proper state of adjustment, and if he is correct as to the distance, the *difference* in elevation of those two summits would have been obtained therefrom with more accuracy than from the barometrical measurements. No one capable of appreciating all the causes of error in the two modes of measurement would probably deny this. Assuming, therefore, the data above given as correct, of which I cannot but express some doubt, it gives a difference in elevation of the two peaks of 578 feet, nearly, whereas the difference shown by Mr. Emmons's barometrical measurements is 739 feet, or nearly 30 per cent. greater, being nearly as much *greater* as the result by my measurement is *less*, showing that, if the 578 feet is taken as the standard, there is about as near an approximation to the truth in the one case as in the other.

The barometer I consider a very valuable instrument, and have made much use of it, as being a cheap and expeditious mode of arriving at an approximate knowledge of the general features of a country; but that it will afford, by a single observation, in the hands of practiced or unpracticed observers, and under all circumstances, results as much to be depended on for their accuracy as would be inferred from Mr. Emmons's statement, cannot be conceded.

The principal sources of error in the use of this instrument are its great liability, particularly the mountain barometer to get out of repair. The difficulty also of arriving at a correct knowledge of the change of pressure, or condition of the atmospheric column

which sustains the column of mercury, arising from fluctuations, that are independent of temperature, and for which no provision is made in most formulas, and the discrepancy in the results as given by different formulas, all claiming to be equally correct.

Errors from these sources when they occur so as to affect the result *differently*, may neutralize each other, but when they operate the *same way*, may produce a very considerable deviation from the truth. In the observations of Mr. Emmons, the barometer at Whiteface was compared with the barometer at Burlington and Albany, and if I rightly understand him, the mean of the two was taken, the difference being about 100 feet less at the former than at the latter. The time of making the observations was 6, A. M. of the same day, Sept. 21. In the record which he gives of the state of the barometer at the two latter places at noon of the same day, the fact is made known that while the barometric column *fell* at the one place it *rose* at the other, causing a difference equivalent to upwards of 100 feet of elevation. Computing the elevation of the place of observation at Burlington at 6, A. M. above tide from the observation at Albany at the same time, and it gives 500 feet, nearly. Taking the observations made at the same places at 12, M. of the same day, and the result is 390 feet, nearly. Which of these is correct, or whether either is only known from the fact that the elevation in question has been ascertained by the common mode of levelling to be 372 feet, nearly, giving a maximum deviation from the truth in two observations only, of 128 feet, nearly. In the case of the observation on the summit of Whiteface, there exist no data by which the *relative* conditions of the atmospheric column as compared with the same column at Burlington and Albany can be ascertained.

Whiteface is about 35 miles west of Burlington, the nearest of the points mentioned, but far enough, it is believed, for considerable difference to exist. But *one* observation is recorded as having been made on its summit and that not under the most favorable circumstances, since it is stated that the "wind was strong from the northeast and cloudy." In the case of Mt. Marcy, the comparison was made with the barometer at Albany. In consequence of the greater distance of the places of observation, a much greater error might result than in the case of the observations at Whiteface and Burlington. That the greater discrepancy between the barometric and trigonometric elevations of Mt. Marcy

compared with Whiteface is attributable in some degree to this cause, it is most certainly not unreasonable to suppose.

Again, a considerable discrepancy in barometric results may arise from the difference in the different formulas used in making the computations. Mr. Emmons makes the elevation of Mt. Marcy above tide 5,594 feet. Mr. Redfield, by another formula, makes it from the same observations 127 feet less, and by yet another formula which has been found by comparison with the known elevation of objects by levelling to give results quite near the truth, it is somewhat less than the elevation obtained by Mr. Redfield. In the case of the Whiteface Mt. the elevation by this latter formula, computing from Mr. Emmons's observations, is less than that given by him by about 290 feet, or about 100 feet *lower* than the elevation as derived from trigonometrical measurement.

If these causes of error exist, and the tendency of all combined is to affect the altitude in the same way, of which there is no evidence to the contrary, it is not difficult to imagine, that Mr. Emmons's barometric measurement of Mt. Marcy may be farther from the truth than he is willing to admit.

The propriety of this conclusion, independent of all other considerations, is I conceive most fully warranted in the great discrepancy of the *relative barometric* altitudes of the peaks in New York and Vermont already described, as shown by the trigonometrical measurement.

The statement made by me in the report alluded to at the head of this article, was, I believe, clearly warranted by the circumstances of the case, and as such was entitled to a degree of consideration in no respect inferior to that which can be reasonably claimed in behalf of Mr. Emmons's measurement. It was most certainly no wish or intention of mine, in making that statement, to disparage, in the least, the labors of Mr. Emmons; and it was not imagined that he could consider the statement as having that tendency; but since, from the tenor of his remarks, he has thought proper to construe it in that light and to pronounce so unequivocally (to use a very mild term) in respect to the superiority of his barometrical measurements, I am compelled, very reluctantly, I confess, to state the facts in detail which influenced my judgment and which I believe fully justify me in all I have advanced upon the subject.

New York, May, 1839.

## Art. VII.—*Account of a Tornado;* by Willis Gaylord.

Having visited and examined the scene of the tornado, so well described by Mr. Willis Gaylord of Otisco, Onondaga Co., N. Y., in the Genesee Farmer, Nov. 10, 1838, we also can bear witness to the tremendous devastation which that whirlwind produced.

We were on the ground in September, about two months after the event. Before the tornado, a region of 4 or 500 acres had been covered by a dense forest of pine trees, many of them very tall and large; roads had been cut through this forest and a few solitary houses were planted in it, here and there. Now we looked in vain over the whole tract for a single perfect tree. Those which had not been uprooted or broken in two near the ground, were shivered and twisted off at different elevations, leaving only a portion of a shattered trunk, so that not a single tree top, and hardly a single branch were found standing in the air: there were instead only mutilated stems, presenting a striking scene of desolation wherever our eyes ranged over the now almost empty aerial space. On the ground the appearances were still more remarkable. The trees were interwoven in every possible way so as to form a truly military abattis of the most impassable kind, nor immediately after the gale, could any progress be in fact made through the gigantic thickets of entangled trunks and branches, without the labor of bands of pioneers, who cut off the innumerable logs that choked every avenue. We had before seen many avenues made through forests by winds, prostrating the trees and laying them down in the direction of its course: but never had we seen such a perfect desolation by a gyratory movement, before which the thick and lofty forest and the strongest framed buildings vanished, in an instant, and their ruins were whirled irresistibly around like flying leaves or gossamer.

Still it was truly wonderful that people were buried in the ruins of their houses, and travellers with their horses and cattle, were exposed to this driving storm of trees which literally filled the air, and still not a single life was lost, although some persons were wounded.

We were assured that this wind had marked a track of devastation for twenty miles or more, but this was the scene of its greatest ravages. Two or three miles from this place, we saw a

wing of a house which had been moved quite around so as to form a right angle with its former position, and still the building was not broken.—*Eds.*

"On the afternoon of the 25th of July, 1838, (says Mr. Gaylord,) a violent tornado passed over part of the county of Allegany, N. Y., rarely equalled in its destructive effects, and giving a most striking illustration of the peculiar movements of the wind in these aerial currents. It was noticed in some of the journals at the time; but happening to cross its route, in passing up the Genesee valley in the succeeding month, we were so much interested with the appearance as to be induced to prepare the following sketch for the readers of the Farmer.

"The first appearance of severe wind, was, as we learned, in the town of Rushford, some fifteen miles from the place where we observed its effects. The day was hot and sultry, and the course of the gale was from the N. of W. to S. of East. At its commencement in Rushford, it was only a violent thunder gust, such as are frequently experienced, but it soon acquired such force as to sweep in places every thing before it. In its passage the same violence was not at all times exerted; some places seemed wholly passed over, while in the same direction and at only a small distance whole forests were crushed. In the language of one who had suffered much from the gale, 'it seemed to move by bounds, sometimes striking and sometimes receding from the earth,' which indeed was most likely the case.

"It passed the Genesee river in the town of Belfast, a few miles below Angelica, and its fury was here exerted on a space of country perhaps a mile or a mile and a half in width. The country here is settled and cleared along the river, but the road passes at a little distance from the river, and at this point wound through one of the finest pine woods to be found on the stream. Of course when it came over the higher lands from the N. W., the tornado crossed the river and the plain before encountering the groves of pine. In the space occupied by the central part of the tornado, say three-fourths of a mile in width, nothing was able to resist its fury. Strong framed houses and barns were crushed in an instant, and their fragments and contents as quickly scattered to every point of the compass; while those out of the direct line were only unroofed, or more or less domaged. Large oaks and elms, were literally twisted off, or crushed like reeds.

"The road from the north approached the pine woods on what was the northern verge of the tornado, and the first appearance of the country in front was that of woodlands in which all the trees had been broken off at the height of 20 or 30 feet, leaving nothing but countless mutilated trunks. On entering the narrow passway, however, which with immense labor had been opened through the fallen trunks, it was perceived that much the largest part of the trees had been torn up by the roots, and lay piled across each other in the greatest apparent confusion imaginable. Fortunately for our view of the whole ground, a few days before our arrival, fire had been put in the 'windfall,' and aided by the extreme dry weather, the whole was burned over so clean, that nothing but the blackened trunks of the trees were remaining, thus disclosing their condition and position, most perfectly. This position was such as to demonstrate beyond the possibility of a doubt, the fact that the tornado had a rotary motion against the sun, and in perfect accordance with the course which we in a former volume of the Farmer have ascribed to such electric aerial currents, a theory first developed by Mr. Redfield of New York.

"The first tree met with, prostrated by the tornado, was a large pine, which lay with its top exactly to the N. of W. or precisely against the general course of the storm. Hundreds of others lay near in the same direction on the outer part of the whirl, but immediately after entering the fallen timber the heads of the trees began to incline to the centre of the space torn down, and south of this the inclination was directly the reverse until the outside of the whirl was reached, when they all lay with their tops to the east. This almost regular position of the fallen timber, was most distinct in the bottom courses, or that which was first blown down, those that resisted the longest, being, as was to be expected, pitched in the most diverse directions. That there was also an upward spiral motion, causing a determination of the rushing air to the centre of the whirl would appear probable from the fact that articles from the buildings destroyed were carried high in the air, and then apparently thrown out of the whirl, into the common current; and also from the fact that a large majority of the trees both to the south and the north of the centre of the gale, lay with their heads inclined to that point, while the centre was marked by the greatest confusion imaginable. A diagram formed of a continued succession of circles moving from the right to the

left would illustrate the position of the trees first uprooted, as these lay as when first crushed by the approach of the whirlwind.

"Many curious facts illustrative of the force of the wind was related by the inhabitants in and near the place. A farmer attempted to drive his team of horses to the barn, but the tempest was too soon upon him. When the rush was over, and it was but seemingly a moment, he found the barn torn to pieces, himself about thirty rods in one direction from it, and his horses as many rods the other, and what was most remarkable with scarcely a fragment of the harness upon them. A wagon was blown away, and a month afterwards one of the wheels had not been found. A house standing near the Genesee river, and a little out of the line of the gale, was completely covered with mud that must have been taken from the bed of the river. And appearances render it very evident that near the centre of the whirl the water was entirely taken from the channel."

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ART. VIII.—*On Meteoric Stones.**—From the Annual Account of the progress of Physics and Chemistry, by BERZELIUS, in the Annual Reports of the progress of the sciences by the members of the Royal Academy of Science in Sweden.

Arsberättelser om Vetenskapernas Framsteg. D. 31. Mars, 1835. Stockholm.

**Translated for this Journal, by Rev. W. A. LARNED.**

METEORIC stones, as inorganic masses occurring on the surface of the earth, present also an object for mineralogy, the more interesting since they give us information of the mineral products

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* Berzelius published a paper on Meteoric Stones in the Transactions of the Royal Academy of Science, for 1834, pp. 115—183 This was translated in several Scientific Journals in Europe. An abstract appeared in the London and Edinburgh Phil. Mag. vol. ix, pp. 429—441, from which an account of the fall of the meteoric stone at Blausko, and of its analysis, was published in this Journal, vol. xix, pp. 175—176. Berzelius himself, made an abstract of his paper in the Reports of the progress of the sciences for 1835, pp. 230—238, which is here translated entire. As a recent analysis of meteoric iron from Clairborne, Ala., by Dr. C. T. Jackson, published in this Journal, vol. xxxiv, pp. 332—337, made known the existence of chlorine, and a still more recent one of meteoric iron from Ashville, N. C., by Prof. C. U. Shepard, detected not only chlorine, but also uncombined silicon, neither of which are mentioned by Berzelius, it was thought a translation of the present paper would be interesting.—*Tr.*

of other planetary bodies, and of their likeness or unlikeness to those of the earth. I have communicated in a paper addressed to the Royal Academy of Science,* examinations of various meteoric stones, undertaken with the design of studying them as mineral species, and of thereby enabling myself to determine of what different minerals they are composed. The occasion of the investigation was afforded by the friendly commission which Reichenbach of Blansko gave me to examine the composition of a meteoric stone, whose glancing apparition within the atmosphere of the earth, on the 25th of November, 1833, about 6 o'clock in the evening, he himself had witnessed, and of which, with very great expense and labor, he finally succeeded in collecting the scattered fragments in the region about Blansko. The meteoric stones which I examined, have fallen near Blansko in Moravia, Chantonnay in France, Lautolax in Finland, Alais in France, and Ellenbogen in Bohemia, and I have also analyzed the meteoric iron made known by Pallas from the region between Abekansk and Krasnojarsk in Siberia. From the analyses referred to, I believe I have discovered that the meteoric stones are minerals; as it is absurd to suppose that minerals can be formed in the air out of the elements of the air, they cannot be atmospheric products, and the less so, as many of them present cavities, which are filled with a mineral of another color and probably of a different composition, which it were a plain absurdity to consider as being possibly formed in them during the few moments the attraction of the earth would suffer so heavy a body to remain in the atmosphere. They become such elsewhere. They are not cast out from the volcanos of the earth, for they fall everywhere, not merely nor oftenest in the near or remote neighborhood of a volcano; their external appearance is unlike a terrestrial mineral, unlike any thing which the volcanos eject. Their containing unoxidized malleable iron, proves that water is not found, and perhaps, not air, in their former abode. They must, therefore, come from some other planet, which has volcanos. The one nearest us is the moon, and the moon has gigantic volcanos compared with the earth. The moon has no atmosphere to retard the volcanic projectiles. Collections of water do not appear to exist on it, in a word, among the probable sources, the moon is

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* Kongl. Vetensk. Acad. Handl. 1834, p. 115.

the most probable. To get an idea of the elements of another planetary body, were it only the one lying nearest us, the moon, gives to such an examination an interest which in itself it would be destitute of.

The general results of my investigations have been, that meteoric stones of two sorts have fallen on the earth. Those which belong to the same kind, have a like composition and appear to come from the same mountain. The one sort is rare. Hitherto there have not been observed more than three meteoric stones belonging to it, which fell in Stannern in Moravia, in Jonzac and Juvenas in France. They are thus characterized; they do not contain metallic iron, the minerals of which they are composed are more distinctly crystalline, and magnesia is not a prevailing element of them. Of these I have not had any specimen to examine. The other sort is made up of the great number of meteoric stones, which have been hitherto examined. They are frequently so like one another in color and external appearance, that we might believe them to have been struck out of one piece. They contain malleable metallic iron in variable quantity. We have an example of an enormous block, which was constituted of a mere continuous web of iron, the cavities of which the mineral fill up, and which came down whole in the fall, solely because the iron-web held them together. Some are composed more of the mineral and less of iron, in which case they do not cohere, but burst apart from the heat, which the extreme compression of the atmosphere by means of their irresistible velocity, moving with the rapidity of a heavenly body towards the earth, has produced in the few moments they are passing through the air, and from which their outermost covering is continually melted to a black slag thinner than the thinnest postpaper. We may say then, that the meteoric stones supposed to proceed from the moon, come entirely from two unlike volcanos, the eruptions of one of which either take place oftener than the other, or are projected in such a direction as that they oftener reach the earth. Such a circumstance agrees well with the fact, that a certain part of the moon has the earth continually in the zenith and directs all its projectiles straight towards the earth, though they do not proceed straight thither, because they must also suffer the motion, which they had before as parts of the moon. If that is the part of the moon which sends to us the meteoric iron

masses, and if the other parts of the moon are not so full of iron, then we see a reason why that point turns continually towards the magnetic globe of the earth.

The mineral portion of meteoric stones consists of various minerals. 1. Olivine. It contains magnesia and protoxyd of iron, is colorless or grayish, but is sometimes streaked with yellow or green like all the terrestrial olivine. This shows that oxygen is wanting for a higher oxidation of the iron. Like the terrestrial, it is soluble in acids, and leaves the silicious earth in the form of gelatine. It contains like some of the terrestrial, a trace of oxyd of tin and oxyd of nickel. Olivine, however, in the meteoric iron found by Pallas, makes an exception to this, for it is without nickel, and its color is yellow approaching to green; but it contains tin. Olivine comprises about one half the quantity of the unmagnetic minerals. Olivine separates by treating with acids, and the silicious earth is then set free by boiling in carbonate of soda.

Then there remain, 2. *silicates of magnesia, lime, protoxyd of iron, protoxyd of manganese, alumina, potash*, and *soda*, which are not separated by acids and in which the silicious earth contains two species of bisilicates. These are probably blended with more, which I was not able to separate. We may conjecture a species of pyroxene $\left.\begin{matrix}Mg\\f\\C\end{matrix}\right\}S^2$ and a species of leucite where lime and magnesia in the first terms replace a portion of potash and soda. $\left.\begin{matrix}Mg\\C\\N\\K\end{matrix}\right\}S^2+3AS^2$. The pyroxene not having so much color as the terrestrial, is to be attributed to the same cause as the want of color in meteoric olivine.

3. *Chrome-iron.*—This is contained in both kinds of meteoric stones, in both in like small quantity, is never wanting, and is the source of the chrome in meteoric iron. It can be obtained undecomposed if the unmagnetic portion of the meteoric stone is separated with hydro-fluoric acid, and is then, after all the silicious earth is removed, treated with sulphuric acid, after which the sulphates and the gypsum are boiled out, when the chrome iron remains in the form of a black burnt powder. This is the cause of the greyish color in meteoric stones when they are seen in the mass.

4. *Oxyd of tin.*—This is mixed with the chrome-iron. One can satisfy himself of its presence when the last named metal is separated by bi-sulphate of potassa, and the solution in water is treated with sulphuretted hydrogen, when the sulphuret of tin is thrown down. It has a trace of copper.

5. *Magnetic Iron-ore.*—This does not perhaps occur in all. It is taken out with the magnet, when it again manifests its property of dissolving in hydro-chloric-acid with a yellow color and without a disengagement of hydrogen.

6. *Sulphuret of Iron.*—This is found in all. It has been impossible for me to separate any for a distinct examination. All the circumstances seem to show that it consists of one atom of each of the elements. A surplus of sulphur in a mass, where a surplus of iron prevails throughout, is not supposable. One part of it follows the magnet together with the iron, the other part remains in the powder of the stone, as nothing more is given up to the magnet. This is sometimes a larger percentage. Whether this is by a chemical union, as is the case, for example, with the sulphuret of manganese in helvin, or is merely by adhesion to the powder of the stone, my researches could not decide; the latter is the more probable when $Fe\,S$ is weakly magnetic, but the former is not impossible. The sulphuret of iron causes the pulverized meteoric stone to develope sulphuretted hydrogen gas when it is mixed with hydro-chloric-acid.

7. *Native Iron.*—This iron is not pure, although it is altogether malleable. It contains carbon, sulphur, phosphorus, magnesia, manganese, nickel, cobalt, tin and copper. But it is moreover blended with small crystals within the mass, of a union of phosphuret of iron with phosphuret of nickel, and phosphuret of manganese. These are insoluble in hydro-chloric-acid and fall down while in the solution. Their quantity varies. The iron of Ellenbogen gives $2\frac{1}{5}$ per cent., but the Pallasian iron not $\frac{1}{5}$ per cent. of it. A part is so finely divided in the mass of the iron, that what falls down in the solution resembles a black powder. The cause of the Widmanstättian* figures is, that the foreign metals are

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* This refers to figures of a crystalline shape on the surface of some meteoric iron, as of Agram, Siberia, Mexico, &c. first noticed by Widmanstätten. See Beyträge zur Geschichte und Kenntniss meteorischen Stein-und Metall-Massen von D. Carl von Schreibers. p. 70.—*Tr.*

not equally blended, but separate into imperfectly formed crystalline series. If the iron is dissolved in an acid solution of sulphate of iron, the pure iron is set free almost by itself and its laminæ fall down in flakes.

The elementary bodies hitherto found in the meteoric stones make up just a third of those we are acquainted with, namely, oxygen, hydrogen, sulphur, phosphorus, carbon, silicon, chrome, potassium, sodium, calcium, magnesium, aluminium, iron, manganese, nickel, cobalt, tin and copper.

The following analyses of the meteoric iron may be cited; some conducted at the same time by Wherle are added.

| | Iron of Pallas. | Iron of Ellenbogen. Berzelius. | Wherle.* |
|---|---|---|---|
| Iron, | 88.042 | 88.231 | 89.90 |
| Nickel, | 10.732 | 8.517 | 8.44 |
| Cobalt, | 0.455 | 0.762 | 0.61 |
| Magnesium, | 0.050 | 0.279 | —— |
| Manganese, | 0.132 | | 98.95 |
| Tin and copper, | 0.066 | a trace. | |
| Carbon, | 0.043 | | |
| Sulphur, | a trace. | | |
| Metallic phosphurets | 0.480 | 2.211 | |

The metallic phosphurets were found to contain:

| | Of the Pallas Iron. | Of the Ellenbogen. |
|---|---|---|
| Iron, | 48.67 | 68.11 |
| Nickel, | 18.33 | 17.72 |
| Magnesium, | 9.66 | |
| Phosphorus, | 18.47 | 14.17 |
| | 95.13 | 100.00 |

This last result cannot possess entire precision, for the whole quantity of the metal, which I was able to take for analysis, was of the former only 3, and of the latter 2.8 centigrammes. Wherle's analysis will be seen to agree more exactly with mine, when I add that he had in the iron the alloy of phosphorus and manganese, and also of magnesia, which fell as the ammoniophosphate of magnesia with the oxide of iron.

Wherle has cited (in the forementioned Journal) still other analyses of meteoric iron which I here communicate.

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* Baumgartners Zeitschrift III, 222.

| | Agram. | Kap. | Lenarto. |
|---|---|---|---|
| Iron, | 89.784 | 85.608 | 90.883 |
| Nickel, | 8.886 | 12.275 | 8.450 |
| Cobalt, | 0.667 | 0.887 | 0.665 trace of copper. |
| | 99.337 | 98.770 | 99.998 |

Wherle has sought the constant proportions in the metals; this inquiry I regard as fruitless.

But before I conclude this subject, perhaps already sufficiently long for my report, I must subjoin one result more of my examination. The meteoric stone from Allais falls to pieces in water, to an earth, which smells of clay and hay and contains carbon in an unknown union. This shows that in the region of the meteoric stones, minerals fall to pieces to a clay-like mixture as on the earth. Now arose the inquiry, whether this carboniferous earth from the surface of another planetary body contains the organized products, whether indeed organized bodies are thus discovered there, more or less analogous with those of the earth. It is easy to conceive with what interest the answer would be sought. It was not in the affirmative, but to decide in the negative would be to conclude more about it than we are authorized to do. The earth was found to be olivine, containing ferrosulphate of nickel and of tin. The magnet took up the compound oxide of iron in black grains, along with which the microscope detected flitters of metallic iron. Water brought out sulphate of magnesia with small quantities of sulphate of nickel; but nothing organized, as none of the alkalies could be extracted. In a dry distillation were developed carbonic acid gas and water, together with a black gray sublimate, but no burnt oil, no carburetted hydrogen; in a word, the carboniferous substance was not of the same nature as the soil on this earth. There were besides a carbonate and black soot. The sublimate heated in oxygen gave no trace of carbonic acid or of water, and changed to a white, uncrystallized, volatile body, soluble in water, which did not become acid in the process and was not precipitated by nitrate of silver. What this body is I did not know; it remains unknown to me. Is it indeed an elementary body not originally pertaining to our planet? To answer this question in the affirmative would be too hasty.

## Art. IX.—*Terrestrial Magnetism;* by J. Hamilton of Carlisle, Penn.

In the 22d volume of this Journal I suggested the idea, that the magnetic poles coincided with the coldest points in the northern hemisphere, but did not assign the grounds for such a conclusion.

In 1837, Dr. Brewster published his Treatise on Magnetism at Edinburgh, originally prepared for the Encyclopedia Britanica, which contains very full details of the latest researches on that subject.

In the 42d page of this Treatise it is stated, "the discovery of two poles of maximum cold on opposite sides of the north pole of the earth, which was announced by Sir David Brewster in 1820, led him and other authors to the opinion, that there might be some connection between the magnetic poles, and those of maximum cold." The opinion advanced by Dr. Brewster, "that there are two poles of greatest cold in the northern hemisphere," it appears, was published in the 9th volume of the Edinburgh Transactions of 1821, and Dr. Dalton in remarking on it, considers it as a probable supposition, and Mr. Kupffer in a memoir read in 1829 to the Russian Academy, explicitely adopts the opinion.

Of all this I knew nothing when I wrote the letter above referred to in 1832, nor until I met with Dr. Brewster's Treastise published in 1837; but drew the inferences therein stated, from the views I entertained of the nature of light and heat,* and from observing a certain correspondence of climate at similar distances from the magnetic poles.

I regard light and heat *in the common acceptation* of these words, as not only material in their nature, but as *compounds* of other simple elements, and suppose the magnetic fluids to be two of those simple substances which enter into their constitution.

From the refined nature of light and heat, we cannot subject them to experiment like other forms of matter, and the difficulty would necessarily be increased, if we have to do with the simple elements of which they are here supposed to be compounded.

That matter exists in such states of refined minuteness of atoms, as to be imperceptible to such senses as we possess, is

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* By the word "heat" I always mean *sensible heat*, and not the unknown principle.

proved by the miasmata, which sometimes impregnate the atmosphere, and yet baffle the skill of the chemist to detect them, although the disease which follows in their train establishes their existence.

If we examine what are termed the magnetic fluids on the poles of the loadstone, it appears that we can neither see, feel, nor taste them, they are not easily disengaged from the particles of the iron, and the only proof of their existence is the attraction they exert. May not this difficulty in perceiving them, arise from their atoms being so exceedingly small, as to be appreciable only to a higher order of senses than we are endowed with. Light and heat will pass through transparent bodies without much difficulty, but Mr. Haldat has shown that the magnetic fluids will not only pass through transparent substances, but through all bodies, even the most dense;—and from this I argue, that they are of greater tenuity than either light, heat, or electricity.

The sun is continually emitting rays which reach the earth in immense quantities, and the question has been significantly asked, but not so easily answered, if they are material bodies, what becomes of this flood of light and heat? They do not accumulate on the earth's surface like snow, but disappear as fast as they arrive. It may be said they become latent. This supposes that light and heat, as usually understood, are perceptions of the mind, and that the exciting causes of these sensations are unknown principles or substances, as evanescent and difficult to apprehend as the magnetic fluids themselves. Now, may it not be, that these substances hitherto incognita, are the identical elements or fluids, whose attraction causes the phenomena of magnetism, and that instead of light and heat being mere sensations, excited by we know not what, they are real material bodies, compounded of these and other elements.

I here suppose, that there are three elements; one of which is common to light and also to heat; that light and heat are each composed of two simple elements; and that when the sun's rays reach the earth, they are decomposed by the attraction of the bodies on its surface, with which their elements unite, and from which they can be again extricated by different processes.

We know that light and heat can be obtained from almost every form of matter, and the idea here offered to explain their disappearance and reappearance, by a decomposition into simpler

elements, and a recombination of those elements through a play of attraction, is not an unphilosophical suggestion.

Colomb has ascertained that "gold, silver, glass, wood, and all substances, whether organic or inorganic, obey the power of the magnet;" so that all substances are susceptible of magnetism. Here then is a striking coincidence between light and heat, and the magnetic fluids; they pervade or influence all terrestrial bodies, and friction will develope light and heat as well as magnetism.

That the violet ray imparts the magnetic virtue to iron, is shown by the expermints of Mrs. Somerville, and by the still more striking experiments of Prof. Zautedeschi, who exposed a horse-shoe artificial loadstone, carrying 13½ ounces, to a strong light of the sun, and after three days it carried an additional weight of three ounces, and ultimately its power was so increased as to carry 31 ounces. These experiments being repeated under an exhausted receiver did not succeed, hence a doubt has arisen as to the source whence the magnetic virtue was derived, but it must be conceded that the sun's rays had some agency in evolving the magnetism, let it come from what source it may, and this is readily explained if we suppose one or more of the magnetic fluids as entering into their composition.

That a compound body should differ not only in its appearance, but in its most striking qualities, from either of the ingredients entering into its composition, is accordant with every day's observation of the chemist; it ought not therefore to be considered so extraordinary, that invisible fluids, such as we find on the poles of the magnet, should, when combined, produce radiant matter, such as either light or heat. In fact, what is the magnetic spark, unless it be the result of the union of the two fluids. But electricity and galvanism also evolve light and heat; and may not there also be different combinations of the three elements, which would account for the evident connexion existing between galvanism, electricity, and magnetism, and also their relation to light and heat.

It is said, however, that light and heat are evolved from the atmosphere by condensation, and this indeed cannot be controverted; nor does it conflict with this hypothesis, for by condensing the air, these elements which are diffused throughout the atmosphere, are brought in contact, a union is effected, and light and heat are the result. The same effect would be produced by

the rapid passage of one of the elements through the air, but with increased energy, for the element itself would enter into the combination. Still I contend that light and heat, or one of them, is the result of the combining of the fluids of either magnetism, electricity, or galvanism, *without the aid of any other body.* This is shown by passing electricity through the exhausted receiver of an air pump, when we have beautiful displays of light, and the effect is the more striking, the more perfect the vacuum.

If there are three simple elements such as I have here supposed, two of which are the fluids on the poles of the loadstone; then let these three be so unequally diffused over and in the earth, as severally to predominate, one at or near the north pole, another at the magnetic equator, and the third at the south pole; each attracting the others, but repelling itself; and we have an elucidation of terrestrial magnetism.

If one of the elements entering into the constitution of light, but not necessary to heat, abounded in the arctic regions, so as to predominate in all terrestrial forms to the exclusion of the elements constituting heat, and this element is identical with one of the fluids on the poles of the loadstone, then it must follow, that the poles of greatest cold would coincide with the magnetic poles, and the isothermal lines have some accordance to the magnetic intensities of different latitude.

The frequent occurrence of the aurora borealis in the northern regions would be explained on this hypothesis, from one of the constituents of light predominating in the arctic circle; and the reason of its affecting the needle be at once shown: so I think a solution may be afforded, for the curious facts, that heat while it imparts the magnetic virtue to soft iron, diminishes with its increase the power of the loadstone, while a white heat entirely destroys it, and a red heat reverses the poles.

I admit that these views are merely hypothetical, but they are part of a more extended theory, which runs its ramifications through all the phenomena of nature, according with so many facts, that I cannot regard it as merely visionary; but I admit that much deliberation and caution are requisite in advancing such positions, lest we should disturb science with unfounded speculations.

ART. X.—*Explosion of Hydrogen and Oxygen, with remarks on Hemming's Safety Tube;* by Prof. J. W. WEBSTER of Harvard University.

THE occurrence of several explosions of the compound blow-pipe of Dr. Hare, in the hands of experienced chemists, is well known; and the student can take up none of the modern chemical books without being made aware of the danger of using an imperfect or ill contrived form of the apparatus. In the use of two separate reservoirs for the gases, and the double concentric jet, it is impossible that explosion can occur. But it has, as those accustomed to use this splendid instrument* are well aware, been modified in various ways, with the desire to render it more portable, safe or convenient. The repetition of the early experiments of Dr. Hare and Prof. Silliman, by the late Dr. Clarke, of Cambridge, (Eng.) and his disregard of the claims of these gentlemen, are also well known; but it is somewhat singular, that so many of the British chemical writers should still incline to give the credit of these brilliant results to him who but repeated what had been long before accomplished in this country. As every chemist must deem the compound blow-pipe, in some form, an essential portion of his apparatus, and as it has even become one of the constituent parts of the cheap, and too often imperfect, "sets of apparatus," manufactured in all parts of the country, for the use of schools of all grades, not unfrequently to be used by beginners or inexperienced persons, it is highly important that every one should be aware of the danger of operating with the *single* vessel as a reservoir of the mixed gases. The convenience of transportation, and the small space it occupies, are great temptations to make use of the single vessel and compressed gases, as in the form first employed in England in the blow-pipe of Mr. Brooke. The tremendous explosions which took place with this instrument in the hands of Dr. Clarke, and of several others, the defences erected by the operators for personal protection, and the modifications in the jets, *ad infinitum*, with which the philosophical journals teemed, are too well known to be described. But

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* For this invention our distinguished countryman, Dr. Hare, has recently been most deservedly honored by the American Academy of Arts and Sciences with the Rumford medals.

the encomiums bestowed upon the contrivances of Gurney, the oil cylinder of Prof. Cumming, the layers of wire gauze as suggested by Wollaston, &c., have now given place to the safety tube of Mr. Hemming, which is in fact a modification of the faggot of capillary tubes proposed by Wollaston.

This tube was first publicly exhibited by Mr. Hemming at the meeting of the British Association for the advancement of Science, in 1832, and is fully described in the published report. The description is quoted by the late Dr. Turner in his Elements, with the remark that all previous modifications of the apparatus "are rendered unnecessary by the Safety Tube lately proposed by Mr. Hemming." An authority like this, and one which has become the guide of so many, will undoubtedly lead to the employment of this tube, as well as to its construction, by inexperienced persons; and without previous care to test its safety in the severest manner, its use may be attended with the destruction, not only of apparatus, but of life.

I have been induced to make these remarks in consequence of a terrific explosion which occurred in my laboratory a few days since; and to show how much care was taken to test the safety of the instrument before it was exhibited to my class, the following notes of some of the test experiments are taken from my record.

The tube was constructed of sheet brass, 6 inches in length and $\frac{3}{4}$ths of an inch in diameter, the size recommended by Hemming. This was closely packed with iron wire (No. 22), each wire extending through the entire length of the tube. The close approximation of the wires was increased by the introduction of a pointed rod of the same metal and same length; this was driven forcibly through the centre of the bundle of wires. Thus the spaces between the wires were exceedingly minute, and it was with difficulty that air could be forced through by blowing with the mouth. It is hardly necessary to remark, that a large cooling surface was thus produced, and that flame applied at one extremity would be far more effectually cooled down by it, than by the wire gauze when held over a gas flame, or when surrounding ignited gaseous matter, as in the safety lamp.

The tube was terminated at each end by a female screw to receive stop cocks. In my first experiments, the Hemming's tube was prolonged at each end by a leaden tube about four feet

in length, to increase the cooling surface; and bladders, containing hydrogen and oxygen gases in the proportions that compose water, were attached to the two extremities. The stop cocks being opened, the gases were forced from one bladder into the other several times through the leaden tubes and that of Hemming's interposed, thus ensuring their mixture both in the bladders and tubes. The apparatus was now placed in the open air, and an arrangement made which allowed me to explode one of the bladders and observe the effect without danger. The one bladder alone exploded. This experiment was repeated many times, shortening the leaden tubes each time, until they were entirely removed, and bladders were attached directly to the Hemming's tube. One of them was then exploded, but the flame was arrested as completely as in the previous trials.

Having repeated the experiment with the Safety Tube alone several times, and uniformly finding it impossible to explode both bladders, I now did not hesitate to hold the tube in my hand, and to apply a flame to one bladder; this was repeated several times, and in no instance was explosion communicated from the one bladder to the other. Mr. Hemming is stated to have operated before the members of the British Association with the bladder under his arm; and Dr. Hare in his letter to Dr. Dalton,* states that he has employed the mixed gases with safety, more than an hundred times, allowing them to explode as far into the tube of efflux as where the contrivance in question† was interposed, without explosion extending beyond it.

The safety of the tube having been so thoroughly tested with the bladders, I now substituted for one of them a strong globe 12 inches in diameter, made of 22 oz. copper; this, as well as the bladder was filled with the mixed gases. The apparatus was placed out of doors, and, with the necessary precautions as to personal safety, the mixture in the bladder was fired, but that in the copper globe did not explode. The same result always occurred in repeating this, and in no trial could I cause the flame to traverse the Hemming's tube.

My next experiments were made without the bladder. A small jet, having an orifice of about $\frac{1}{20}$ of an inch diameter,

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* Amer. Jour. Vol. xxxiii, p, 196.

† Dr. Hare alludes to some improvement he has made in Hemming's tube, but has not informed us in what it consists.

was screwed into the tube, the mixed gases were condensed in the globe by a syringe, until on opening the stop cock they issued out with considerable velocity. The globe thus charged was again placed in the open air, with arrangements for igniting the gases as they issued from the jet and for protection, should explosion occur. They were ignited without explosion, and continued to burn quietly. The experiments were repeated with different proportions of the gases and under different pressures, always without explosion.

The safety of the tube had thus been severely tested, and there was apparently no cause to apprehend accident, so that I saw no objection to exhibit it to my class in connection with the usual illustrations of the properties of hydrogen gas and the compound blow-pipe. Accordingly, two bladders, filled as before, were attached to the two ends of the tube, the stop cocks opened, and one bladder being fired, the other did not explode. This latter, by applying a flame to an orifice and exploding it, was afterwards proved to have retained the mixture.

A few days after this, I exhibited the gases burning at the jet on the copper globe, to several gentlemen who happened to visit the laboratory; and subsequently employed the same apparatus, filled with the mixed gases, before the audience usually attending the lectures at the Cambridge Lyceum. It was used as a compound blow-pipe, and particularly for obtaining the intense light from lime in the focus of a reflector, as proposed by Lieut. Drummond. No accident or inconvenience occurred. On the following day, as the gases had not been entirely consumed, it was used on my lecture table before the class.

It may be thought that unnecessary precaution was taken to ascertain the safety of an apparatus that had come to us with the sanctions I have already alluded to; but we cannot be too careful in experiments of danger, especially with new apparatus, and when made in this country from description only, and by artists not always aware of its applications, or not prepared to put it to the test to which such instruments are usually subjected by the best English makers.*

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* An instance occurred under my own observation a few years since, where a person was compressing air into a copper globe, made in this vicinity, when it burst, wounding the operator very severely in the hand and face.

Having occasion to exhibit the compound blow-pipe in my lecture on the 16th of May, in addition to my usual method with two separate gas holders, and the double, concentric jet, the copper globe was charged with the mixed gases, but with a smaller proportion of hydrogen, viz. 1½ vols. to 1 vol. of oxygen, for the purpose of making some comparative experiments. After using the gases in the separate vessels, I proceeded to operate with the new instrument; the jet was ignited and a few experiments made with confidence and safety. Having closed the stop cock, I removed (as I had often done before) a very short piece from the end of the jet for the purpose of obtaining a somewhat larger flame, to be directed upon a lump of magnesia. The orifice exposed was now $\frac{1}{10}$th of an inch in diameter and about 6 inches from the end of the Hemming's tube, being at the extremity of a small brass tube bent upwards at an angle of 45°, the same which had been used in all the previous experiments. The globe was nearly in contact with my person, the jet and Hemming's tube projecting horizontally in front of me from right to left. With the right hand the stop cock was opened, and the emission of the gases adjusted; with the left the jet was ignited. The slight crackling noise, which all must be familiar with who have operated with the compound blow-pipe, occurred several times, and the gases were extinguished, but no communication of flame or explosion of the gases in the globe took place.

On again applying a lighted paper to the jet, however, the copper globe exploded with tremendous noise and force, shattering several glass vessels standing upon the table and shelves in the rear, and projecting the torn copper, stop cocks, and tubes, in different directions. My fingers, resting upon the stop cock, were bruised; and the right shoulder severely, by a large fragment of the copper, which in its course robbed me of no small part of the coat sleeve, and the cuff was entirely carried away. The force of the explosion was exerted principally in the direction of the tube and jet in front of me, or I should not probably have escaped with so little injury. The noise and concussion were deafening, and my hearing was not perfectly restored for several hours. No one, fortunately, of the class was injured; the usual good order and attention were but momentarily interrupted; the lecture was proceeded with, and the remaining experiments performed.

On examination afterwards, it appeared that a large fragment of the globe had been projected behind me, striking a shelf in which it caused a large indentation, and a fissure of more than two inches in length, and of nearly one in depth. One large piece of copper was projected over the heads of some persons present out of an open window several yards distant from the table. The windows being open, but one pane of glass was broken; but the sound was heard in all the college buildings, and at a very considerable distance beyond.

The question now arises, how could this explosion have occurred with an apparatus which had been subjected to such apparently thorough and severe tests? I have carefully examined the tube and every fragment of the apparatus, and recalled all the circumstances and arrrangements, without being able to discover any imperfection or assignable cause. I have made experiments with the tube and bladders since the accident, and with the same results as before the explosion: the tube is as perfect as ever, and as incapable of transmitting explosion.

That the stop cocks and every part of the globe were perfectly tight, and allowed of no leakage by which a stream of the gases might have come in contact with the flame at the jet, I cannot but feel confident, as nothing of the kind was observable during the condensation or in the previous trials. The apparatus was new and very faithfully made.

It was found by Mr. Hemming, that when the gases contained a portion of water mechanically suspended in them, the flame would return through the tube proposed by Mr. Gurney, where layers of wire gauze, &c. are employed, and even in its improved form, where layers of asbestos are interposed. But with the tube filled with wires, exhibited before the British Association, it is stated to have been *impossible* to produce explosion, even when the gases were made to recede by withdrawing the pressure on the bladder. In the present case no recession could have taken place from diminution of pressure, as the compressed gases were rushing out with great velocity.

How far the compression of the gases may have aided the combination of their bases, we are unable to say; but from the experiments of Biot, we know that it must be made suddenly and violently, for when gradually applied, as in the sinking of a mixture of the gases to the depth of one hundred and fifty fathoms,

where the compression would be about thirty atmospheres, no such effect was produced. And in the present case, the condensation had been made rapidly, and two hours before the explosion occurred. It is not impossible that the state of compression and close approximation of the particles of the gases may have aided the rapid combination, and but a slight increase of temperature have been required to produce explosion, which may have been caused in the tube, by the slight explosions to which I have before alluded as so often occurring in the jet. The capacity of the jet and stop cock, in front of the safety tube, was sufficient to contain but about one cubic inch of the gases, and the combustion of so small a quantity could have had but little influence in raising the temperature of the safety tube; probably none, when we consider that the compressed gases were expanding as they passed out, and no doubt attended with the usual effect, the absorption of caloric.

In a letter now before me, Dr. Hare has suggested the heating effect of the previous slight explosions, as the most probable cause of the final explosion; but for the reasons just stated, I am constrained to seek for some more satisfactory explanation.

Although it would be difficult, if not impossible, to prove that electricity, from the presence of the different metals entering into the construction of the various parts of the apparatus, or developed by, or evolved from the gases, or the products of their first partial combustions, was not the immediate cause of this explosion, it would be equally difficult, in the present state of our knowledge, to prove that it was. The ignition of platinum sponge, and the combination of oxygen and hydrogen which it effects, it is well known, were, when first observed, attributed by Dobereiner to electricity, which has not been disproved, or satisfactorily explained, even by the researches of Faraday.

Having communicated to the distinguished inventor of the compound blow-pipe a brief notice of the occurrence which I have described, it will not, I trust, be deemed an undue liberty to remark, that in the letter above referred to, Dr. Hare appears to consider all explosions as dependent on "a mysterious electrical reversal of polarities," and that we are not as yet able to determine all the modes by which such reversals may be induced.

From the first experiments made with the Hemming's tube, it is obvious that it cannot be said that the wires were not of

sufficiently small size to arrest explosion. Neither can it be supposed that the outlet at the extremity of the jet was insufficient for the expansion of the exploding mixture, and that in consequence of that expansion, the inflamed gases were driven back into the copper globe. This expansion must have been far greater than 15 or 18 times, as deduced from Davy's experiments, to have overcome the force exerted by the gases, which at the moment were issuing from the globe, under a pressure probably of nearly two atmospheres.

The expansion of hydrogen and oxygen gases by explosion, has not, I think, been satisfactorily determined; and Davy, whose results are most commonly adopted, does not appear to have deemed his own conclusive. I have made some experiments on the subject, and should not have offered the preceding remarks until more satisfactory results had been obtained, had it not been necessary to defer the investigation to an interval of more leisure.

When water is mechanically suspended in the gases, the danger of retraction and explosion is undoubtedly increased, but the influence of the small quantity formed in the jet on the occurrence of the slight explosions already alluded to, must have been in a great measure, if not altogether, counteracted by the elasticity of the issuing gases.

The cause of this explosion is certainly mysterious; but in whatever manner we may attempt to explain it, it must be regarded as additional evidence of the danger of employing the gases in a state of previous mixture, and of the importance of adhering to the use of two separate vessels and the concentric jet. With these, although less convenient on some accounts, there are other advantages; their perfect safety, however, is alone sufficient to induce us to recommend them, and them alone, to the chemical student.

The trials with the tube of Hemming *previous* to the occurrence of this explosion, seemed to warrant the statement in its favor which has been made in a note in the edition of my Manual of Chemistry, now passing through the press.

Laboratory of Harvard University, Cambridge, June 5th, 1839.

## Art. XI.—*On the Greek Conjugations*; by Prof. J. W. Gibbs.

The conjugations found in our common grammars, have usually been formed by writers directing their attention to a single language, and are probably the best for merely practical purposes.

It often happens, however, that there is another arrangement of the conjugations which enters more deeply into the nature of the verb, separates more closely between primary and derivative forms, and prepares the way for more successful comparisons with other languages.

The classification to which I allude is based, for the most part, on the broad distinction between internal or strong inflection which takes place within the root itself, and external or weak inflection which consists in the addition of new syllables and leaves the root untouched.

As the internal inflection, which consists principally in the change of the vowel or in the reduplication of initial letters, is found in radical or primitive verbs, and has a manifest analogy in different languages, it has of late engaged the attention of philologists.

These remarks apply more or less to Greek, Latin, and Teutonic, including English, verbs. I shall confine my attention at present to the Greek.

### *Strong Inflection.*

Strong verbs in Greek are divided by philologists, for the sake of exhibiting their vocalic changes, into four classes.

The tenses chosen for the purpose of showing these vocalic changes are the 2 aorist, which usually exhibits the radical vowel, the 2 perfect, and the present.

### *Class I.*

This class includes verbs whose radical vowel undergoes no change in inflection.

| | | |
|---|---|---|
| 2 aor. *ἐγράφην*, | perf. *γέγραφα*, | pres. *γράφω*. |
| 2 aor. *εὗρον*, | perf. ——— | pres. *εὑρω*. |
| 2 aor. *ἐῤῥίφην*, | perf. *ἔῤῥιφα*, | pres. *ῥίπτω*. |
| 2 aor. *ἐκόπην*, | perf. *κέκοπα*, | pres. *κόπτω*. |
| 2 aor. *ἐκρύβην*, | perf. *κέκρυφα*, | pres. *κρύπτω*. |
| 2 aor. *ἔδαον*, | perf. *δέδαα*, | pres. *δάω*. |
| 2 aor. *ἔδιον*, | perf. *δέδια*, | pres. *δίω*. |
| 2 aor. *ἐφύην*, | perf. *πέφυα*, | pres. *φύω*. |

Here belong a few verbs with $\alpha$ made and continued long by position, one verb with $\eta$, and a few doubtful examples with $\bar{\iota}$.

| | | |
|---|---|---|
| 2 aor. ἔμαρπον, | 2 perf. μέμαρπα, | pres. μάρπτω. |
| 2 aor. ——— | 2 perf. λέλαμπα, | pres. λάμπω. |
| 2 aor. ἔπληγον, | 2 perf. πέπληγα, | pres. πλήσσω. |
| 2 aor. ἔβρῑθον, | 2 perf. βέβρῑθα, | pres. βρῑθω. |

The Latin language exhibits examples not only of *a*, but of other vowels, made and continued long by position; as, *lambo*, pret. *lambi*; *verto*, pret. *verti*; *mordi*, pret. *momordi*; *curro*, pret. *cucurri*.

## *Class II.*

This class includes verbs whose radical vowel α is changed in the course of inflection into other vowels.

| | | |
|---|---|---|
| 2 aor. ἔτραπον, | 2 perf. τέτροπα, | pres. τρέπω. |
| 2 aor. ἔλεγον, | 2 perf. λέλογα, | pres. λέγω. |
| 2 aor. ἔδαρκον, | 2 perf. δέδορκα, | pres. δέρκω. |
| 2 aor. ἐστάλην, | 2 perf. ἔστολα, | pres. στέλλω. |
| 2 aor. ἔταμον, | 2 perf. τέτομα, | pres. τέμνω. |
| 2 aor. ἔκτανον, | 2 perf. ἔκτονα, | pres. κτείνω. |
| 2 aor. ἐφθάμην, | 2 perf. ἔφθορα, | pres. φθείρω. |

This second class has a striking analogy to the I. and II. Teutonic conjugations; as,

CONJUGATION I.

| | | |
|---|---|---|
| Goth. past *brak*, | part. *brukans*, | pres. *brika*. |
| Germ. past *brach*, | part. *gebrochen*, | pres. *brechc*. |
| Eng. past *brake*, | part. *broken*, | pres. *break*. |

CONJUGATION II.

| | | |
|---|---|---|
| Goth. past *halp*, | part. *hulpans*, | pres. *hilpa*. |
| Germ. past *half*, | part. *geholfen*, | pres. *helfe*. |
| Eng. past *holp*, | part. *holpen*, | pres. *help*. |

This second class of Greek verbs, like the I. and II. Teutonic conjugations, has its radical vowel usually either preceded or followed by a liquid.

## *Class III.*

This class includes verbs whose radical vowel *α*, *ι*, *υ*, is lengthened or doubled in certain tenses, *η* being equivalent to double *α*.

| | | |
|---|---|---|
| 2 aor. ἔκρᾰγον, | perf. κέκρᾱγα, | pres. κράζω. |
| 2 aor. ἔκλᾰγον, | perf. κέκληγα, | pres. κλάζω. |
| 2 aor. ἐτᾰχην, | perf. τέτηχα, | pres. τήκω. |
| 2 aor. ἔδᾰκον, | perf. δέδηκα, | pres. δάκνω. |
| 2 aor. ἔφᾰνον, | perf. πέφηνα, | pres. φαίνω. |

| | | |
|---|---|---|
| 2 aor. ἔκρῐγον, | perf. κέκρῑγα, | pres. κρίζω. |
| 2 aor. ἔβρῠχον, | perf. βέβρῡχα, | pres. βρῡχω. |
| 2 aor. ἔμῠκον, | perf. μέμῡκα, | pres. μῡκαω. |

This third class has a striking analogy to the IV. Teutonic conjugation, where however *ā* has been changed into *ō* or *ū*; as,

| | | |
|---|---|---|
| Goth. past *sloh*, | part. *slahans*, | pres. *slaha*. |
| Germ. past *schlug*, | part. *geschlagen*, | pres. *schlage*. |
| Eng. past *slew*, | part. *slain*, | pres. *slay*. |

## *Class IV.*

This class includes verbs whose radical vowel *ι*, *υ*, is made a diphthong by Guna in the perfect and present; as,

| | | |
|---|---|---|
| 2 aor. ἔπιθον, | perf. πέποιθα, | pres. πείθω. |
| 2 aor. ἔλιπον, | perf. λέλοιπα, | pres. λείπω. |
| 2 aor. ἔφυγον, | perf. πέφευγα, | pres. φεύγω. |
| 2 aor. ἔτυχον, | perf. τέτευχα, | pres. τεύχω. |

In the first and second examples the radical vowel *ι* is made a diphthong by prefixing *ε* or *ο*, as in Sanscrit the same vowel is made a diphthong by prefixing *a*. In the third and fourth examples the radical vowel *υ* is made a diphthong by prefixing *ε*, as in Sanscrit the same vowel is made a diphthong by prefixing *a*. This mode of forming a diphthong out of *i* or *u* by prefixing *a*, is called *Guna* by the Sanscrit grammarians.

This fourth class has a striking analogy to the V. and VI. Teutonic conjugations; as,

CONJUGATION V.

| | | |
|---|---|---|
| Goth. past *draib*, | part. *dribans*, | pres. *dreiba*. |
| Germ. past *trieb*, | part. *getrieben*, | pres. *treibe*. |
| Eng. past *drove*, | part. *driven*, | pres. *drive*. |

CONJUGATION VI.

| | | |
|---|---|---|
| Goth. past *baug*, | part. *bugans*, | pres. *biuga*. |
| Germ. past *bog*, | part. *gebogen*, | pres. *biege*. |
| Eng. past *bow*, | part. *bowed*, | pres. *bowed*. |

In Conj. V. the radical vowel *i* is made a diphthong in Gothic by prefixing *a* or *e*. In Conj. VI. the radical vowel *u* is made a diphthong by prefixing *a* or *i*.

The fourth class of Greek verbs, like the V. and VI. Teutonic conjugations, has the radical vowel usually followed by a single consonant and that not a liquid.

The verbs belonging to these four classes are all primary or radical verbs.

### *Weak Inflection.*

Weak verbs in Greek, or verbs externally inflected, include some primary verbs whose root or theme ends with a vowel or diphthong, and all derivatives or secondary formations.

### *Primary Verbs.*

| | | |
|---|---|---|
| pres. *δράω,* | fut. *δράσω,* | perf. *δέδρακα.* |
| pres. *πταίω,* | fut. *πταίσω,* | perf. *πέπταικα.* |
| pres. *παύω,* | fut. *παύσω,* | perf. *πέπαυκα.* |
| pres. *δέω,* | fut. *δήσω,* | perf. *δέδεκα.* |
| pres. *σείω,* | fut. *σείσω,* | perf. *σέσεικα.* |
| pres. *νεύω,* | fut. *νεύσω,* | perf. *νένευκα.* |
| pres. *τίω,* | fut. *τίσω,* | perf. *τέτικα.* |
| pres. *βόω,* | fut. *βώσω,* | perf. *βέβωκα.* |
| pres. *λούω,* | fut. *λούσω,* | perf. *λέλουκα.* |
| pres. *πτύω,* | fut. *πτύσω,* | perf. *πέπτυκα.* |

### *Secondary Verbs.*

In *άω;* as, *τιμάω* from *τιμή*, and this from *τίω; κομάω* from *κόμη.*

In *έω;* as, *πονέω* from *πόνος*, and this from *πένω; κοιρανέω* from *κοίρανος.*

In *εύω;* as, *πομπεύω* from *πομπή*, and this from *πέμπω; δουλεύω* from *δοῦλος.*

In *όω;* as, *στεφανόω* from *στέφανος*, and this from *στέφω; δουλόω,* from *δοῦλος.*

In *ύω;* as, *ταινύω* from *τείνω.*

In *άζω;* as, *στενάζω* from *στένω; δωριάζω* from *δῶρος.*

In *ίζω;* as, *βαπτίζω* from *βάπτω; μηδίζω* from *μῆδος.*

In *ύζω;* as, *ἑρπύζω* from *ἕρπω.*

In *αίνω;* as, *σημαίνω* from *σῆμα.*

In *ύνω;* as, *ἡδύνω* from *ἡδύς.*

In *ω* directly, from nouns or adjectives; as, *ποικίλλω* from *ποικίλος.*

ART. XII.—*Notice of Prof. Ehrenberg's Discoveries in relation to Fossil Animalcules*; also Notices of Deceased Members of the Geological Society of London, being extracts from the Address of Rev. WILLIAM WHEWELL, B. D. F. R. S., President of the Society; delivered at the Annual Meeting, Feb. 15, 1839.

THE Council have adjudged the Wollaston medal for the present year to Prof. Ehrenberg, for his discoveries respecting fossil Infusoria and other microscopic objects contained in the materials of the earth's strata. We all recollect the astonishment with which, nearly three years ago, we received the assertion, that large masses of rock, and even whole strata, are composed of the remains of microscopic animals. This assertion, made at that time by Professor Ehrenberg, has now not only been fully confirmed and very greatly extended by him, but it has assumed the character of one of the most important geological truths which have been brought to light in our time: for the connection of the present state of the earth with its condition at former periods of its history, a problem now always present to the mind of the philosophical geologist, receives new and unexpected illustration from these researches. Of about eighty species of fossil Infusoria which have been discovered in various strata, almost the half are species which still exist in the waters: and thus these forms of life, so long overlooked as invisible specks of brute matter, have a constancy and durability through the revolutions of the earth's surface which are denied to animals of a more conspicuous size and organization. Again, we are so accustomed to receive new confirmations of our well-established geological doctrines, that the occurrence of such an event produces in us little surprise; but if this were not so, we could not avoid being struck with one feature of Prof. Ehrenberg's discoveries;—that while the microscopic contents of the more recent strata are all freshwater Infusoria, those of the chalk are bodies (*Peridinium Xanthidium*, *Fucoides*,) which must, or at least can, live in the waters of the ocean. Nor has Prof. Ehrenberg been content with examining the rocks in which these objects occur. During the last two years he has been pursuing a highly interesting series of researches with a view of ascertaining in what manner these vast masses of minute animals can have been accumulated. And the result of

his inquiries is,* that these creatures exist at present in such abundance, under favorable circumstances, that the difficulty disappears. In the Public Garden at Berlin he found that workmen were employed for several days in removing in wheelbarrows masses which consisted entirely of fossil Infusoria. He produced from the living animals in masses, so large as to be expressed in pounds, tripoli and polishing slate similar to the rocks from which he had originally obtained the remains of such animals; and he declares that a small rise in the price of tripoli would make it worth while to manufacture it from the living animals as an article of commerce. These results are only curious; but his speculations, founded upon these and similar facts, with respect to the formation of such rocks, for example, polishing slate, the siliceous paste called *keiselguhr*, and the layers of flint in chalk, are replete with geological instruction.

As the discoveries of Prof. Ehrenberg are thus full of interest for the geological speculator, so they have been the result, not of any fortunate chance, but of great attainments, knowledge, and labor. The author of them had made that most obscure and difficult portion of natural history, the infusorial animals, his study for many years; had travelled to the shores of the Mediterranean and the Red Sea in order to observe them; and had published (in conjunction with Prof. Müller) a work far eclipsing any thing which had previously appeared upon the subject. It was in consequence of his being thus prepared, that when his attention was called to the subject of fossil Infusoria, (which was done in June, 1836, by M. Fischer) he was able to produce, not loose analogies and insecure conjectures, but a clear determination of many species, many of them already familiar to him, although hardly ever seen perhaps by any other eye. The animals (for he has proved them to be animals, and not, as others had deemed them, plants) consist, in the greater number of examples, of a staff-like siliceous case, with a number of transverse markings; and these cases appear in many instances to make up vast masses by mere accumulation without any change. Whole rocks are composed of these minute cuirasses of crystal heaped together. Prof. Ehrenberg himself has examined the microscopic products of fifteen localities, and is still employed in extending

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* Abhandl. Kön. Ak. Wissensch. Berlin. 1838.

his researches; and we already see researches of the same kind undertaken by others, to such an extent, as to show us that this new path of investigation will exercise a powerful influence upon the pursuits of geologists. We are sure therefore that we have acted in a manner suitable to the wishes of the honored Donor of the medal, and to the interests of the science which we all in common seek to promote, in assigning the Wollaston medal to Prof. Ehrenberg for these discoveries.

Although it is not necessary as a ground for this adjudication, it is only justice to Prof. Ehrenberg to remark, that his services to geology are not confined to the researches which I have mentioned. His observations, made in the Red Sea, upon the growth of corals, are of great value and interest; and he was one of the distinguished band of scientific explorers who accompanied Baron von Humboldt in his expedition to the Ural Mountains. And I may further add, that even since the Council adjudged this medal, Prof. Ehrenberg has announced to the Royal Academy of Sciences of Berlin new discoveries; particularly his observations on the organic structure of chalk; on the freshwater Infusoria found near Newcastle and Edinburgh, and on the marine animalcules observed near Dublin and Gravesend; and, what cannot but give rise to curious reflections, an account of *meteoric paper* which fell from the sky in Courland in 1686, and is found to be composed of Confervæ and Infusoria.

I now proceed to notice some of the most conspicuous names, both among our own countrymen and foreigners, which have been removed by death from our lists since last year.

In Sir Abraham Hume the Society has lost a member who was at all times one of its most strenuous friends and most liberal supporters, and especially in its earliest periods, when such aid was of most value. Indeed he may in a peculiar manner be considered as one of the Founders of the Society. English geology, as is well known, evolved itself out of the cultivation of mineralogy, —a study which was in no small degree promoted, at one time, by the fame of the mineralogical collections of Sir Abraham Hume and others. The Count de Bournon, exiled by the French revolution in 1790, brought to England new and striking views of crystallography, resembling those which Haüy was unfolding in France; and was employed to arrange and describe the mineralogical collections of Sir John St. Aubyn and Mr. Greville, and

especially the collection of diamonds of Sir Abraham Hume, of which a description, illustrated with plates, was published in 1816. Some years before this period a few lovers of mineralogy met at stated times at the house of Dr. Babington, whose influence in preparing the way for the formation of this Society was mentioned with just acknowledgment in the President's Address, in 1834, by Mr. Greenough; and certainly he, more fitly perhaps than any other person, could speak of the merits and services of his fellow laborers. Of the number of these Sir Abraham Hume was one; although not, I believe, one of those who showed their zeal for the pursuits which associated them by holding their meetings at the hour of seven in the morning, the only time of the day which Dr. Babington's professional engagements allowed him to devote to social enjoyments of this nature.

Out of the meetings to which I refer this Society more immediately sprung. The connection of mineralogy with geology is somewhat of the nature of that of the nurse with the healthy child born to rank and fortune. The foster-mother, without being even connected by any close natural relationship with her charge, supplies it nutriment in its earliest years, and supports it in its first infantine steps; but is destined, it may be, to be afterwards left in comparative obscurity by the growth and progress of her vigorous nursling. Yet though geology now seeks more various and savoury food from other quarters, she can never cease to look back with regard and gratitude to the lap in which she first sat, and the hands that supplied her early wants. And our warm acknowledgments must on all due occasions be paid to those who zealously cultivated mineralogy, when geology as we now understand the term, hardly existed; and who, when the nobler and more expansive science came before them, freely and gladly transferred to that their zeal and their munificence.

The spirit which prevailed in the infancy of this Society, and to which the Society owed its permanent existence, was one which did not shrink from difficulties and sacrifices; and among the persons who were animated by this spirit Sir Abraham Hume was eminent; his purse and his exertions being always at the service of the body. He gave his labors also to the Society by taking the office of Vice-President, which he discharged with diligence from 1809 to 1813. He died in March last at the great age of ninety, being then the oldest person both in this and in the Royal Society.

Mr. Benjamin Bevan was a civil engineer, and throughout his life showed a great love of science, and considerable power of promoting its purposes. He instituted various researches, theoretical and practical, on the strength of materials;* and it was he who first proved by experiment the curious proposition, that the Modulus of Elasticity of water and of ice is the same. In 1821 he wrote a letter to the secretary of this Society, recommending that the form of the surface of this country should be determined by barometrical measurements of the heights of a great number of points in it,—the barometer which was to be used as a standard being kept in London. Mr. Bevan and Mr. Webster were commissioned to procure a barometer, and Dr. Wollaston recommended one of Carey's barometers, but it does not appear that any further steps were taken. I may remark that recent researches have further confirmed the wisdom of Mr. Bevan's suggestion, that heights should be measured, as all other measurements are made, from some fixed *conventional* standard, instead of incurring the vagueness and inconsistency which result from assuming the existence of a natural standard, such as the level of the sea.

Nathaniel John Winch was born at Hampton Court in the year 1769, and after a voyage into the Mediterranean, and travels in various countries in Europe, settled at Newcastle-upon-Tyne as a merchant. He had early paid great attention to botany, which he continued to cultivate during a long life, and kept up a correspondence with all the leading botanists in Europe. He was one of the earliest, and always one of the most active members of the Literary and Philosophical Society of Newcastle; and, in conjunction with a few of his friends, gave to that town a scientific and cultured character, which still distinguishes it. He was one of the honorary members of this Society; and contributed to its meetings, in 1814, "Observations on the Geology of Northumberland and Durham," and in 1816, "Observations on the Eastern Part of Yorkshire,"† which were printed in the fourth and fifth

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* To Mr. Bevan our Journal is indebted for many valuable communications.—Ed. *Lon. Phil. Mag.*

† Besides these papers, Mr. Winch published: "The Botanist's Guide through the Counties of Northumberland and Durham. By N. J. Winch, J. Thornhill, and R. Waugh." 2 vols. 1805.—"Flora of Northumberland and Durham." In the Transactions of the Newcastle Natural History Society, vol. 2.—"Essay on the Geographical Distribution of Plants through the Counties of Northumberland, Dur-

volumes of our Transactions. In these he stated his object to be to combine with his own observations much interesting information on the subjects of the quarries, and coal and lead mines, of those districts, which had long been accumulating, and was widely diffused among the professional conductors of the mines. And these memoirs, though not containing much of originality in their views and researches, were, at the time, of considerable utility. He died May 5th, 1838, and, by his will, left to this Society a very considerable and valuable mineralogical collection, now in our Museum.

Mr. William Salmon of York, was one of the persons who was most zealously and actively engaged in the examination of the celebrated Kirkdale Cavern. He measured and explored new branches of the cave in addition to those first opened, and made large collections of the teeth and bones, from which he sent specimens to the Royal Institution of London, and to Cuvier at Paris. The bulk of his collection was deposited in the Philosophical Society at York, then newly established.

I now proceed to notice our deceased Foreign Members.

François-Dominique de Reynaud, Comte de Montlosier, was born at Clermont in Auvergne, April the 16th, 1755, the year of the celebrated earthquake of Lisbon. He was the youngest of twelve children of a family of the smaller nobility of that province, and was remarkable at an early age for the zeal with which he pursued various branches of science and literature.

Count Montlosier must ever be considered as one of the most striking writers in that great controversy respecting the origin of basaltic rocks, which occupied the attention of mineralogists during the latter half of the last century; and to which, in so large a degree, the progress and present state of geology are to be ascribed. The theory of the extinct volcanos of Auvergne, the subject of his researches, was the speculation which gave the main impulse to scientific curiosity on this point. It is true that he was not the originator of the opinions which he so ably expounded. Guettard, in 1751, had seen, vaguely and imperfectly, that which it now appears so impossible not to see, the evidences

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ham, and Cumberland." First edition, 1820; second edition, 1825.—"Contributions to the Flora of Cumberland." 1833.—"Addenda to the Flora of Northumberland and Durham." 1836.

of igneous origin in the rocks of that district: and the elder Desmarest, whose examination of them began in 1763, had made that classification of them, which is the basis, and indeed the main substance, of the views still entertained with regard to the structure of that most instructive region. His map of the district, published in 1774 (in the Transactions of the Academy of Paris *for* 1771, according to a bad habit of that body still prevailing,) exhibits the distinction of modern currents of lava, ancient currents, and rocks fused in the places where they now are, which distinction supplies a key to the most extraordinary phænomena, while it reveals to us a history more wonderful still. But striking and persuasive as this view was, and fitted, apparently, to carry with it universal conviction, the theory which it implied, collected, as it seemed at the time, from one or two obscure spots in Europe, was for a while resisted and almost borne down by the opposite doctrine of the aqueous origin of basalt; which came from the school of Freyberg, recommended by the power of a connected and comprehensive system,—a power in science so mighty for good and for evil. Montlosier's Essay on the Volcanos of Auvergne, which appeared first in 1788, was, however, not written with any direct reference to this controversy, but was rather the exposition of the clear and lively views of an acute and sagacious man, writing from the fullness of a perfect acquaintance with the country which he described, in which, indeed, his own estate and abode lay. In its main scheme, although Desmarest's is mentioned with just praise,* the object of this Essay is to criticise and correct a work of M. Le Grand d'Aussy, entitled *Voyage en Auvergne.* But as the main additions to sound theory which this work contains, (a point which here concerns us far more than its occasion and temporary effect,) we may, I think, note the mode in which he traces in detail the effects which the more recent currents of lava (those which follow the causes of the existing valleys) must have produced upon the courses of rivers and the position of lakes; and the idea, at that time a very bold and, I believe, a novel one, that lofty insulated ridges and pinnacles of basalt, which tower over the valleys, have been cut into their present form by the long-continued action of fluviatile waters,

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* After mentioning Guettard, he says, "Les mémoires de M. Desmarest, publiés quelques années après, entrainèrent tout-àfait l'opinion publique." (p. 20.)

aided by a configuration of the surface very different from the present. The striking and vivid pictures which Montlosier draws of such occurrences, are to the present day singularly instructing and convincing to those who look at that region with the geologist's eye. After publishing this essay, M. Montlosier, a man of varied and commanding talents, became involved in the political struggles of his time, and was an active member of the National Assembly, to which he was sent as Deputy of the Noblesse of Auvergne. In his place there he resisted in vain the proposals for the spoliation of the clergy; and one speech of his on this subject was very celebrated. After witnessing some of the changes which his unhappy country had then to suffer, he became an exile, and resided in London, where for some years he was the editor of the *Courier Français*, a royalist journal. Under the empire, he returned to France, and was employed in the Foreign Office of the Ministry, but recovered little of his property except a portion of a mountain, which was too ungrateful a soil to find another purchaser. The situation however could not but be congenial to his geological feelings; for his habitation was in the extinct crater of the Puys de Vaches. The traveller, in approaching the door of the philosopher of Randane, had to wade through scoriæ and ashes; and from the deep basin in which his house stood, a torrent of lava, still rugged and covered with cinders, has poured down the valley, and at the distance of a league, has formed a dike and barred up the waters which form the lake of Aidat;—a spot celebrated by Sidonius Apollinaris, Bishop of Clermont in the fifth century, as the seat of his own beautiful residence, under the name of Avitacus. It is curious to remark that Sidonius does not overlook the resemblance between his own mountain and Vesuvius:

> "Æmula Baiano tolluntur culmina cono,
> Parque cothurnato vertice fulget apex."

In this most appropriate abode M. de Montlosier was, in his old age, visited at different times by several distinguished English geologists, some of whom are now present; and invariably delighted them with his unfading interest in the geology of his own region, his hospitable reception, and I may add, his lofty and vigorous presence, according well with his frank and chivalrous demeanor. His ardor of character had shown itself in early age: "From my first youth," thus his Essay opens, "I occupied my-

self with the natural history of my province, in spite of repulse and ridicule." The same spirit involved him in other struggles to the end of his life; and, indeed, we may almost say, beyond it. He took a prominent part in the political controversies of his day; and few works on such subjects, which appeared in France in modern times, produced a greater fermentation than his "Mémoire à consulter" on the subject of the Jesuits. In this work he maintained that the position of the Jesuits in France was dangerous and illegal; and he must be considered as the originator of that movement in consequence of which their body was, a few years later, suppressed by the government. The expression of his opinions respecting the conduct and influence of the clergy of his country was condemned by the ecclesiastical authorities, and was deemed by them of a nature to exclude him from that recognition of his being a son of the Catholic Church, which is implied by the performance of the funeral rite according to its ordinances. This, however, did not prevent the inhabitants of the neighborhood and the military stationed at Clermont from showing the regard which his intercourse with them had inspired, by attending his sepulture in great numbers. He was buried in a spot previously selected by himself, in the crater of the extinct volcano in which his abode was, in the middle of the scenes which he had from his earliest years loved and studied, and taught others to feel a deep interest in. He died at the age of 83, on his way to Paris in order to take his seat in the Chamber of Peers, of which he was a member.*

Anselme-Gaëtan Desmarest, honorary member of the Royal Academy of Medicine, and Professor of Zoology at the Royal Veterinary College of Alfort, was the son of Nicolas Desmarest, who has just been mentioned as the predecessor of Montlosier in his theory of the volcanic origin of Auvergne. The son also employed himself upon the same district; and published an enlarged

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* Besides his "Essay on the Extinct Volcanos of Auvergne," M. de Montlosier was the author of the following works: "Mémoire à consulter sur un Système Religieux et Politique tendant à renverser la Religion, la Société et le Trône" (1826.) "Dénonciation aux Cours Royales rélativement au Système Religieux et Politique signalé dans le Mémoire à consulter," (1826.) "Mémoires de M. le Comte de Montlosier sur la Révolution Française, le Consulat, l'Empire, et les principaux Evènements qui ont suivis 1755–1830." Of this work two volumes have appeared, which bring the narrative down to the author's quitting the National Assembly in 1790.

and improved edition of his father's map of Auvergne;—a work which is still spoken of with admiration, for its fidelity and skillful construction, by all who explore that country. But the labors of the younger Desmarest were principally bestowed upon the other parts of natural history. We possess in our Library, extracted from various journals, and presented us by the author, his "Notes on the impression of marine bodies in the strata of Montmartre," published in 1809; his "Memoir on the Gyrogonite," published in 1810; to which he added, 1812, the recognition of the analogy of this fossil with the fruit of the Chara, pointed out by his brother-in-law M. Léman; his review of a work by M. Daudebard de Ferussac, on the Fossils of Freshwater Formations, in 1813; his memoir on Two Genera of Fossil Chambered Shells, in 1817; and his "Natural History of Proper Fossil Crustaceans," published in 1822 along with M. Brongniart's "Natural History of Fossil Trilobites." In the "Dictionnaire d'Histoire Naturelle," the article Malacostracés, which contains a complete account and classification of Crustaceans, is by M. Desmarest, with others on the same subject. In this work all the articles on Crustaceans had originally been assigned to Dr. Leach; but when the lamented illness of that distinguished naturalist prevented his finishing this task, it was committed to Desmarest, who carefully studied the labors of his predecessor; and, with most laudable industry and self-denial, made it his business to follow his method as closely as possible. He also published a separate work on Crustaceans in 1825.

Count Kaspar Sternberg was one of those persons, so valuable in every country, who employ the advantages of wealth and rank in the cultivation and encouragement of science. He belonged to a younger branch of one of the best and oldest families in Bohemia; and was closely connected with the persons of most elevated station in that country. He was born the 6th of January, 1761, and received a distinguished education at Prague; not only, as was then common among the Bohemian nobility, through private tutors, but by following the public course of the university. He was created Canon of the Chapter of the metropolitan church at Ratisbon, which, obliging him to receive the lower degree of holy orders, bound him to celibacy. At Ratisbon, then a considerable place, and the seat of the Diet of the German empire, he formed friendships with several eminent persons, and especially

with Count Bray (afterwards Bavarian minister at various courts,) a man of letters, and a distinguished botanist. Count Sternberg also cultivated botany, and became an active member of the Botanical Society of Ratisbon. During the time that Germany was a prey to the miseries of war, he retired to his hereditary country seat Brzezina, in the circle of Pilsen, in the northwestern part of Bohemia. Here his attention was early drawn to the coal formation, of which mineral he possessed an extensive estate at Radnitz. He soon formed the intention of publishing representations of the fossil vegetables belonging to the coal strata. These had already begun to excite the attention of geologists. Some of these works, containing notices on such subjects, preceded the existence of sound geology, as the *Herbarium Diluvianum* of Scheuchzer, the *Sylva Subterranea* of Beutinger, and the *Lapis Diluvii Testis* of Knoor.* At the beginning of the present century, Faujas de St. Fond had published in the Annales du Muséum some impressions of leaves, not indeed belonging to the coal, but to a later formation. These impressions were examined and determined by Count Sternberg, in the Botanical Journal of Ratisbon, in 1803. In the following year appeared the first truly scientific work on this subject, the "*Flora der Vorwelt*" of Schlotheim, in which the great problem which was supposed to demand a solution was, Whether the vegetables of which the traces are thus exhibited belong to existing or to extinct kinds? Count Sternberg was in Paris when he received the work of Schlotheim, and he studied it carefully by the aid of the collections which exist in that metropolis. He published in the Annales du Muséum a notice on the analogies of these plants, but concluded with observing, that a greater mass of facts was requisite; and that, these once collected, the general views which belong to the subject would come out of themselves.

Bearing in mind this remark of his own, when fortune, after the storming of Ratisbon in 1809, set him down in the midst of the great coal formations of Bohemia, he proceeded forthwith to manage the working of his mines, so as to preserve as much as possible the most remarkable impressions of fossils. Combining his

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* To the earlier works on this subject we may add Martin's *Petrificata Derbiensia*, published 1809; and Parkinson's Organic Remains, (1804,) which contains many plates of vegetables.

own specimens with those found in other places, he began to publish, in 1820, his "Essay towards a Geognostic-botanical Representation of the Flora of the Pre-esisting World." In this work he not only gave a great number of very beautiful colored engravings of vegetable fossils, but also attempted a systematic classification of them. But he stated, in the first portion of his work,* that the problems, important alike for botany and geology, which offered themselves, could only be solved by combined labors on a common plan; and after mentioning the various European Societies to which he looked for assistance (among which he includes this Society,) he adds, "Bohemia and the hereditary states of the Austrian empire, I am ready, with some friends of science, to make the subject of continued investigation." The specimens of which he published representations, with many more, formed the Count's collection at his castle of Brzezina; but he declared in the outset, that as soon as the National Bohemian Museum at Prague was provided with the means of receiving and displaying this collection, the whole should be transferred from Brzezina to the capital. This was afterwards done; and in this and other ways he was one of the principal founders of the Museum at Prague. He also gave notice, that while the collection continued in his own residence, it was open to the inspection of every lover of science, even in the absence of the Count himself.

The publication of Sternberg's *Flora der Vorwelt* went on till 1825, after which it was discontinued till 1838, when two parts appeared, terminating the work. In this last publication he states that he is compelled to give up this undertaking, having been in a great measure deprived of sight for two years, so that he was obliged to devolve the greater part of such labors upon MM. Corda and Presl. His hearing also failed him. He adds, however, that though thus no longer able to pursue the path which he has trodden for twenty years, he shall not fail to render to the science, of which he was one of the founders, any service which may be in his power. This publication was the crowning labor of his life, for he did not long survive it; he retained, however, to the last the elasticity and activity of his mind. He died very suddenly at his country seat already mentioned, on the 20th of December, 1838, being carried off by apoplexy in his 78th year.

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* *Erster Heft*, p 16.

In his own country his influence was highly salutary: he directed his attention especially to the improvement of the national education; and we cannot be surprised at finding such a person very soon at the head of nearly all the institutions for literary and public purposes. He founded the National Museum of Bohemia, of which he was the President; gave to it his library and his various collections, and further enriched it at various periods of his life. He was, indeed, zealous in all that concerned Bohemian nationality, and was an accomplished master of the language and literature of his country: since his death I am assured that there is hardly one Bohemian of any class who does not mourn for him as for a most respected benefactor. Throughout Germany, he was looked to by all who felt an interest in science with a respect and regard which he well merited. The emperor Francis held him in the highest esteem; he gave him the title of Privy Councillor, and the Grand Cross of St. Leopold, held in that monarchy as a distinguished honor.

In the preceding sketch I have mentioned Schlotheim as one of the predecessors of Count Sternberg in fossil botany. Although this writer died in 1832, and was an honorary member of this Society, he has never been noticed in the annual address; I may therefore here add a few words with reference to him. Baron E. F. von Schlotheim was Privy Councillor and President of the Chamber at the court of Gotha, and his collection of Petrifactions has long been celebrated throughout Germany. Besides his Flora of a Former World, or Descriptions of remarkable Impressions of Plants, which appeared in 1804, he published, in 1820, 'Petrifactenkunde, or the Science of Petrifactions according to its present condition, illustrated by the Description of a Collection of petrified and fossil remains of the animal and vegetable kingdom of a former world.' And in 1822 and 1823 he published Appendixes to this work. His collection was also further made known by articles in Leonhard's Mineralogical Pocket Book and in the Isis. After his death a new description of this collection was announced, but whether it appeared I am not able to say. Schlotheim's introduction to his account of his collection contains some extensive geological views.

It is only justice to M. de Schlotheim to add here what is said of him by M. Adolphe Brongniart, whose own labors on fossil vegetables have been of such inestimable value to the geologist, and

are every year increasing in interest. "Almost half a century," he says, "elapsed, during which no important work appeared on this subject. It was not till 1804 that the 'Flora of the Ancient World', by M. de Schlotheim, again turned the attention of naturalists to this branch of science. More perfect figures, descriptions given in detail and constructed with the precision of style which belongs to botany, and moreover some attempts at comparison with living vegetables, showed that this part of natural history was susceptible of being treated like the other branches of science: and we may say, that if the author had established a nomenclature for the vegetables which he described, his work would have become the basis of all the succeeding labors on the same subject."

The following gentlemen were elected, Feb. 15, 1839, Officers and Council of the Society for the year ensuing.

*President.*—Rev. W. Buckland, D.D., Professor of Geology and Mineralogy in the University of Oxford.

*Vice-Presidents.*—G. B. Greenough, Esq. F.R.S. and L.S.; Leonard Horner, Esq. F.R.S. L. & E.; Charles Lyell, jun. Esq. F.R.S. & L.S.; Rev. Adam Sedgwick, F.R.S. and L.S., Woodwardian Professor in the University of Cambridge.

*Secretaries.*—Charles Darwin, Esq. F.R.S.; William John Hamilton, Esq.

*Foreign Secretary.*—H. T. De la Beche, Esq. F.R.S. & L.S.

*Treasurer.*—John Taylor, Esq. F.R.S.

*Council.*—Professor Daubeny, M.D. F.R.S. & L.S.; Sir P. Grey Egerton, Bart. M.P. F.R.S.; W. H. Fitton, M.D. F.R.S. & L.S.; Prof. Grant, M.D. F.R.S.; Rev. Prof. Henslow, F.L.S.; W. Hopkins, Esq. M.A. F.R.S.; Robert Hutton, Esq. M.P. M.R.I.A.; Sir Charles Lemon, Bart. M.P. F.R.S.; Prof. Miller, M.A.; R. I. Murchison, Esq. F.R.S. & L.S.; Richard Owen, Esq. F.R.S.; Sir Woodbine Parish, K.C.H. F.R.S.; George Rennie, Esq. F.R.S.; Rev. Prof. Whewell, F.R.S.

ART. XIII.—*Account of a Meteor seen in Connecticut, December* 14, 1837; *with some considerations on the Meteorite which exploded near Weston, Dec.* 14, 1807; by EDWARD C. HERRICK, Rec. Sec. Conn. Acad.

ON the evening of Thursday, the 14th of December, 1837, a meteoric fire-ball of great splendor, was seen by many persons in this vicinity. At the time of its appearance, Mr. A. B. Haile and myself were abroad here, engaged in making observations on shooting stars in concert with Messrs. F. A. P. Barnard, J. D. Dana, and J. H. Pettingell, in New York. Our attention was exclusively directed to the northeastern part of the heavens, and the western quarter, in which the meteor appeared, was unfortunately concealed from view at our station by a contiguous building. A brilliant flash suddenly illuminated the roof on which we stood, and concluding at once that the unseen source of the light must be a meteor of uncommon splendor, we noted the time. It was 7h. 39m. 32s. P. M.

I was not able, after much inquiry, to ascertain the position of the meteor at its first appearance. The testimony of two independent witnesses several rods distant from each other, near the middle of this city, coincided as to the azimuth of the point of extinction, and furnished me with data for fixing it at S. 89° W. The altitude was less certain, but appeared to be about 9°.

The meteor was much more splendid than Venus. It was apparently, according to the estimates of different observers, from one fourth to three fourths as large as the full moon. It moved downwards from a point between S. and W. at an angle of from 30° to 50° with a vertical, to the point before indicated, where it appeared to explode, and to throw down one or more large fragments. The time of flight was 1 or 1.5 seconds. It was attended by a long and broad train of scintillations, some part of which remained visible for about ten seconds, and of course, long after the meteor was extinct. It is uncertain whether the report of the explosion was heard here. If audible at this distance, the sound would not have arrived until two or three minutes after the disappearance of the meteor, and unless very heavy, it might easily have passed unnoticed amidst the noise of the city.

Thinking it probable that some portion of this meteor had fallen in the southwestern part of this State, I made inquiries by letter in various towns in that region. At Wilton, (28 miles, about W. by S. from this city,) the meteor was seen by several persons, and their testimony was kindly collected for me, by Mr. Hawley Olmstead. Mr. Edward Baldwin, one of the observers at that place, has given me some additional details. For observations at a spot about seven miles S. W. from Wilton, I am indebted to Rev. Theophilus Smith of New Canaan. At *Wilton*, the meteor passed a little south of the zenith, in a westerly direction. It gradually enlarged until just before the explosion, and at the largest, it was of "the magnitude of one fourth of the moon." The brilliancy of the meteor was exceedingly great, and rendered minute objects on the ground distinctly visible. Its light was so intense that it arrested the attention of a person engaged in study in his room with two candles burning before him. The train was long, and remained in sight several seconds after the explosion. When 25° or 30° above the horizon, the meteor exploded with a heavy report, which, according to the mean of various estimates, reached the ear in about thirty seconds afterwards. One or more of the observers saw luminous fragments descend towards the ground. Most of the witnesses imagined that they heard a whizzing noise, as the meteor passed over their heads; but this could not have been noticed until several seconds after the meteor's passage.

After collecting numerous observations from witnesses in various places, I found that they were not sufficiently exact and concordant to enable me to give a satisfactory account of the meteor, and I was for some time uncertain whether it was worth while to publish them. The following are the results which were obtained. The *direction* of the path of the meteor while visible, was probably one or two degrees N. of W. and inclined downwards. The *length of its path*, and its *relative velocity*, can only be roughly conjectured, as I do not find that any one saw the meteor at its earliest appearance. Its path while visible may have been from 15 to 20 miles long. On account of the direction of the earth's motion at the moment, the relative velocity of the meteor was probably less than the absolute, but how much less cannot be determined, as we do not know the angle which its path made with our horizon. When it exploded, it was three or four miles above the surface of the earth, and probably over the

town of Poundridge, Westchester County, N. Y.* The fragments which fell, doubtless lie buried somewhere in that region,—to be discovered, perhaps, in future ages. The larger part of the meteor appears to have passed on, in its path around the sun. The *size* of the meteor can be ascertained in the present instance with about as much certainty as in most similar cases. Respecting this particular there is always abundant room for fallacious results. The observer is commonly too unskillful to make a just comparison of the angular size of the meteor with that of any celestial body; and he is moreover, without being conscious of it, often prone to exaggeration. He rarely sees the bare nucleus, but only the envelope of flame and sparks, and that, greatly enlarged by irradiation. Hence, there is danger of making the size of the body much too large, especially when the calculation is based on observations taken at the distance of 50 or 100 miles. The nearer the observer is to the meteor, the less is the probability of error in this respect. In the present instance, an estimate of the apparent size of the meteor by an observer at North Branford, (nearly 40 miles from the place of explosion,) would make the diameter of the meteor ten or twelve times as great as that resulting from the observations at Wilton, only about six miles from the place of explosion. The data from Wilton make the diameter of the meteor about 150 feet, and it was probably a little less than this. The distant observations on the apparent size of the meteor must be rejected.

### *On the velocity of the Weston Meteorite.*

The meteor which cast down stones in several places in and about Weston in this State, on the morning of Monday, December 14, 1807, excited uncommon attention far and wide, and full accounts of its interesting phenomena, were published in the highly valuable memoirs of Professors Silliman and Kingsley,† and of Dr. Bowditch.‡ To the elaborate calculations of the lat-

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* I did not succeed in obtaining any observations on this meteor from the State of New York, but I was not able to make thorough inquiry in that quarter.

† Trans. Am. Phil. Soc. VI, 323; Mem. Conn. Acad. I, 141; Med. Repos. XI, 202. See also a paper in the Churchman's Monthly Mag. New Haven, V, 35; account by Messrs Bronson and Holley in N. Y. Spectator, Jan. 2, 1808; Med. Repos., XI, 418; ib. XIV, 194, (1811.)

‡ Mem. Amer. Acad. III, 213.

ter we are indebted for our knowledge concerning its height, direction, velocity and magnitude.

The case of the Weston meteor is one of exceeding importance, because it is probably the only instance where a meteor from which stones are known to have come to the earth, has been sufficiently well observed for the determination of its velocity. This element is of great value, on account of its bearing on the relation between meteorites and shooting stars. There can indeed be no reasonable doubt, that many of the meteors which have been seen and heard to explode, and whose phenomena have been submitted to calculation, were true meteorites; but this is a case where there is absolute certainty.

Dr. Bowditch ascertained that the course of the Weston meteor "was about S. 7° W., in a direction nearly parallel to the surface of the earth, and at the height of about eighteen miles." It was about a mile further from the earth's surface when it exploded, than when it first appeared. The length of its path from the time it was first seen until it exploded, as determined from the observations made at Rutland, Vt., and at Weston, was at least 107 miles. This space being divided by the duration of the flight as estimated by two of the observers, viz. thirty seconds, we have for the meteor's relative velocity, about three and a half miles a second. The observations made at Wenham, Mass., are probably less exact in this respect, and need not be mentioned here. Every one accustomed to observations on meteors, knows how difficult it is accurately to determine the duration of their visible flight. An inexperienced observer, however intelligent, will frequently give the time, ten or even twenty fold too large. The apparent motion of the Weston meteor, was probably much slower than that of most meteors, but it seems to me highly improbable that its visible flight could have exceeded fifteen or twenty seconds. Mr. Page, the observer at Rutland, Vt., says,—"motion very rapid, probably thirty seconds in sight." The arc traversed by the meteor as there seen, was not over 15 degrees. Now it is scarcely credible that any man could consider as *very rapid*, the motion of a meteor at the rate of one degree in two seconds of time. It will perhaps be deemed improper to introduce here, at this distant period, the recollected observation of one not unversed in science, who saw the meteor from a spot a few miles northwest of this city, and who is confident that it could not have been in sight as long as ten seconds. I will

therefore make no further use of his testimony. There are, however, two considerations which may throw some light on this point.

1. The meteor if a satellite, must have moved with a velocity greater than three and a half miles per second, because if it did not, the earth's attraction would soon have brought the whole mass to the ground. But it is certain that much the greater portion passed on. In order to have done this, through the air, at the height of eighteen miles, it must have had a velocity not less than five miles per second.

2. According to Mr. E. Staples, (one of the observers at Weston,) "when the meteor disappeared, there were apparently three successive efforts or leaps of the fire-ball which grew more dim at every throe, and disappeared with the last."* Soon after the meteor disappeared, were heard three principal heavy reports, which "succeeded each other with as much rapidity as was consistent with distinctness, and all together, did not occupy three seconds." Professors Silliman and Kingsley, who thoroughly examined the region where the stones fell, a few days after the event, say, "We think we are able to point out three principal places where stones have fallen, corresponding with the three loud cannon-like reports, and with the three leaps of the meteor." The account given by Mr. Isaac Bronson, of an investigation made Dec. 19, 1807, by himself and Rev. Horace Holley, confirms this position.

(1.) The most northerly fall was in Huntington, on the border of Weston, near the house of Mr. Merwin Burr. (2.) The second principal deposit was near the house of Mr. William Prince "in Weston, distant about *five miles* in a southerly direction from Mr. Burr's." (3.) The third and probably the largest collection, fell near the house of Mr. Elijah Seeley, "at the distance of about *four miles* from Mr. Prince's."

Although it is not certain that these several masses came in the same direction from the meteoric body, yet until the contrary appears, it may, not unfairly, be assumed that they did; and consequently the interval of space at which they struck the earth,

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* Observers in Wallingford, Meriden, Cheshire, &c., "all agree that its motion was not uniform either in velocity or direction, but that it seemed to bound, or as one of them expresses it, *to move scolloping*." Ch. Mo. Mag., v. 36. This is probably due to the resistance of the air, which, in such cases, must be exceedingly great.

furnishes some measure of the velocity of the meteor relative to the earth's surface. The statement will permit us to allow not quite a second of time between each report, and we thus obtain a velocity as great as four or five miles a second. This result is of course no more than a rude approximation to the truth.

The velocity thus far spoken of, is only the velocity *relative to the earth.* Here the question arises,—if the meteor was not a satellite of the earth, what was its *absolute* rate of motion? Now it will be noticed (p. 133, lines 14, 15) that the path of the meteor must have been nearly in the same direction with that of the earth at the time. Their directions in azimuth were almost identical; the direction of the meteor's path in altitude, appears to have been a little below that of the earth. If the meteor was moving around the sun, then nearly the whole of the earth's velocity (at that season) of rather more than nineteen miles a second,—must be added to the meteor's relative velocity to obtain the true velocity. In this view, its absolute rate of motion will be found to have been at least *twenty miles a second.*

It remains only to inquire, whether it is more probable that the Weston meteorite was a satellite of the earth, or a primary body moving around the sun. If this meteor had passed the earth's surface in the direction opposite to that of the earth's motion, with about the relative velocity which it exhibited, then we might be compelled to consider it a satellite of the earth. But the peculiar direction in which it moved, makes it an ambiguous case. We must therefore resort to other instances, for a solution of the question. Numerous observations on meteoric fire-balls which were without doubt real meteorites, have been made and computed. It has most generally been found, that whenever they come in a direction more or less opposed to that of the earth's motion, their velocity is greater than ten miles a second; which proves them to be in revolution about the sun and not about the earth. Their velocity has indeed more than once, exceeded thirty miles a second. It is then from analogy altogether probable that the Weston meteor was a body revolving around the sun, and that if it had approached the earth from the contrary direction, it would have been found moving with a relative velocity of not less than forty miles a second.

New Haven, Conn.

ART. XIV.—*Some Notice of British Naturalists;* by Rev. CHARLES FOX, Cor. Mem. of the N. Y. Lyc. of Nat. Hist.

Continued from Vol. xxxvi, No. 2, p. 230.

RAY had two contemporaries whose names are still remembered with respect. To the first we owe the origin of British Conchology.

MARTIN LISTER was descended from an old and respectable Yorkshire family; but his parents, having removed from their own county, had settled in Buckinghamshire, where he was born in 1638. His earlier education was superintended by his uncle, Sir Matthew Lister, Physician to King Charles I, and President of the Royal College of Physicans in London. At the usual age he entered the University; and in 1658, being then but 20 years of age, he took his degree at St. John's College, Cambridge. Like Ray he appears to have distinguished himself here by his abilities and his classical attainments: and two years after, he was created by the royal mandate, a fellow of his College. The profession which he now chose to pursue was that of medicine; and having traveled for some time upon the continent, in order to perfect himself, as was then usual for persons of his education, about five years after he had become a fellow, he settled at York to practice as a physician. Whether he had heretofore, paid any attention to the study of Natural History, further than his profession required, does not appear; but it was not till 1671 that he first became an acknowledged writer upon the subject. The only periodical work of importance, the pages of which were at this time open to accounts of miscellaneous scientific discoveries, was the Philosophical Transactions of the Royal Society of London. In this work we find Lister's first paper,—"*Observations on an acid liquor obtained from ants and perhaps other insects.*" After having thus once began, he was a frequent contributor; and he appears to have been not only an acute observer, but likewise a careful collector of miscellaneous facts on a variety of subjects. His papers in the Philosophical Transactions amount, in the whole, to about forty; several of which are upon antiquities, and one or two upon the anatomy of Testacea. But his principal works, and those upon which his fame and usefulness as an author chiefly rest, are—I. *Historiæ Animalium Angliæ, tres*

*Tractatus; Unus de Araneis; alter de Cochleis, tam terrestribus tam fluviatilibus; tertius de Cochleis Marinis. Adjectus est quartus de lapidibus ejusdem Insulæ, ad cochlearum imaginem figuratis.* London, 1678. 4to. II. *Historiæ, sive Synopsis Conchyliorum quorum omnium Picturæ ad vivum delineatæ, exhibentur.* Lond. 1685–92, and a third edition at Oxford, 1770. This latter edition consists of 1059 plates, exclusive of the anatomical ones; but there is very little letter press connected with it. Mr. Granger informs us that the drawings were executed chiefly by his two daughters, Anna and Susanna, and some think that these ladies engraved the plates likewise.

III. *Exercitatio Anatomica de Cochleis maxime terrestribus et Limacibus.* 1694. 8vo.

IV. *Exer. Anat. altera de buccinis flaviatilibus et marinis.* 1695. 8vo.

V. *Exer. Anat. tertia Conchylorum bivalvium.* 1696. 4to.

The plates are remarkable for their fidelity and excellency. In his first work he confines himself chiefly to the shells of the northern counties, and describes sixty-three species. In his second work a large number, not before noted, are added. His other writings, some of which are upon medicine, are numerous; but may be said, in general, to be marked with a propensity to hypothesis, and too strong an attachment to ancient doctrines. He now became well known in the scientific world; his practice as a physician was constantly increasing; and his fame was generally extended. In 1684 he was persuaded to remove to London, in order that he might enjoy the advantages which the metropolis alone could afford him; and in 1698 he was sent on an embassy, with the Earl of Portland, to the Court of France. On his return he published an account of his journey, which was severely satirized, as containing some things which were supposed to be puerile and frivolous. He was elected a fellow of the Royal College of Physicians; and in 1709 he was appointed Physician in Ordinary to Queen Anne. This honor, however, he did not long live to enjoy; for he died February, 1711,—having reached the highest point in his profession. When we read over the list of his numerous writings, we are surprised at his great and unceasing industry. He is a remarkable instance of what a person may do who makes use of *all* his time; for Natural History seems to have been but a recreation to him; and all he did on this subject he

appears to have accomplished during his leisure hours. His professional practice was large; he was by no means unacquainted with the writings of preceding Physicians, and his information on general topics was such as might be expected from one holding the high station in society which he did. What has been justly remarked of those among the ancients who wrote on Natural History, we may apply, without much change, to Lister,—that they were men of enlarged minds, who were far from being confined to one study; that their views were elevated, and their knowledge various and profound; and that while no object appeared too minute for their consideration, their depth of thought preserved them from trifling or unimportant investigations. Lister may be said to be the father of Conchology in England; and his anatomical examinations prove how correct a view he took of the subject. In these writings he has displayed both great accuracy of observation, and indefatigable industry in detecting the most minute particulars of the economy of this part of creation; and we may still refer to his works with profit, instruction, and interest.

Sir Robert Sibbald.—The principal source of information respecting him, is from an autobiography written in 1695, recently published, with other scraps of Scottish history* under the title of "Analecta Scotica." He was descended from a noble family of great antiquity, and enjoyed the influence of a judicious and excellent mother, who was very careful of his education. He was born at Edinburgh, April 15, 1641, and received his education in the high school and university of that city. He then spent two years and a half on the continent, studying medicine at Leyden and in Paris, and cultivating the acquaintance of the leading savans of the day. Having obtained a French diploma of medicine he travelled in various parts of France, and returned through England to Edinburgh in October, 1662. There was in those days no public coach north of York, whence he travelled to Newcastle on horseback with a guide, whom he retained through the remainder of his journey.

On his return to his native country, he projected the plan for establishing a Royal College of Physicians in Edinburgh, and was active in carrying it into effect. In 1686 he is said to have embraced Popery; from which, in a few years, he again recanted.

* Naturalist's Library, vol. ix, p. 18.

His practice was extensive, and it was chiefly as a recreation from his severer duties that he pursued the study of Antiquities and Natural History. He was a man of an active, investigating mind; he had before him a field hitherto altogether unexplored, and in his profession, as well as in these pursuits, he rose to eminence. In the latter part of his life he was knighted, and appointed Physician in Ordinary to King Charles II. He died in 1712. His writings are numerous, as appears by the following list of his works:

Disputatio Medica de variis Tabis speceibus, Lugduni Batavorum; 1661. 4to.
Nuncius Scoto Britannus; Edin. 1683. Folio.
An Account of the Scottish Atlas; Edin. 1683. Folio.
Scotia Illustrata, sive Prodromus Historiæ Naturalis, &c. Edin. 1684. Folio.
Again. 1696. Folio.
Phalainologia Nova, &c.; Edin. 1692. 4to.; reprinted at the instigation of Pennant in 1773.
An Advertisement anent the Xiphias, or Sword Fish, exposed at Edinburgh.
An Essay concerning the Thule of the Ancients; Edinburgh, 1693. 12mo.
Camden's Britannia, Additions to edition of 1695. Folio.
Introductio ad Historiam rerum a Romanis gestarum, &c.; Edin. 1696. Folio.
Auctarium Musæi Balfourani, e Museo Sibbaldiano, &c.; Edin. 1697. 8vo.
Memoria Belfouriana, &c. Edin. 1699. 8vo.
Provision for the Poor in Time of Dearth, &c.; Edin. 1699. 8vo.
An Advertisement anent a rare sort of Whale come in near Cramond; 1701.
Coelii Sedulii Scoti poemata sacra ex MSS. &c.; Edin. 1701. 8vo.
Georgii Sibbaldi, Regulæ bene et salubrita vivendi, &c.; Edin. 1701. 8vo.
Commentarius in Vitam, G. Buchanani; Edin. 1702. 8vo.
The Liberty and Independence of the Kingdom and Church of Scotland Asserted. Three Parts. Edin. 1703. 4to.
An Answer to the Second Letter to the Lord Bishop of Carlisle, &c.; Edin. 1704. 8vo.
In Hippocratis legem et in ejus Epistolam ad Thessalum, &c.; Edin. 1706. 8vo.
Historical Inquiries concerning the Roman Monuments, &c. in N. B.; Edin. 1707. Folio.
The Histories, Ancient and Modern, of the Sheriffdoms of Linlithgow and Stirling; Edin. 1710. Folio.
An Account of the Writers, &c. which treat of N. B. Two Parts. Edin. 1710. Folio.
Miscellanea quædam eruditæ Antiquitatis, &c.; Edin. 1710.
Vindiciæ Prodromi Historiæ Naturalis Scotiæ; Edin. 1710.
History, Ancient and Modern, of the Sheriffdoms of Fife and Kinross; Edin. 1710. Folio.
Reprinted, Cupar Fife; 1803. 8vo.
Commentarius in Julii Agricolæ Expeditiones; Edin. 1711. Folio.
Conjectures concerning the Roman Ports, &c. in the Friths of Forth and Tay; Edin. 1711.
Specimen Glosiarii de Populis et Locis N. B.; Edin. 1711. Folio.
Series rerum a Romanis, post avocatum Agricolam, &c.; Edin. 1711. Folio.
Description of the Isles of Orkney and Zetland; Edin. 1611. Folio.

The "Scotia Illustrated," although the labor of twenty years, manifests but a small acquaintance with the natural arrangement of the subject; and it contains many of the errors of system of the older writers. Each general term is not only strictly defined, but each genus and order are traced back to their original cause. Thus we find one chapter, to introduce an account of the Scotch rivers and brooks, headed, "*De aquâ dulci*"—"*On Fresh Water*," and informing us that "the necessity for fresh water is very great, that both men and wild beasts, and even plants themselves, may drink thereof and be irrigated." Another, the first chapter on animals, is headed, "*De hominum dignitate et præstantiâ*," and includes an account of the creation of man, and his superior worth and dignity in comparison with the inferior orders.

But Sibbald was not only a naturalist, he was a physician by profession; and it was not to be expected that he would omit all mention of a subject to which he had dedicated his life. At that time there was scarcely any production of the earth, the air, or the water, which was not pressed into service. In this respect, and in this department, we are perhaps more deeply indebted to the new and enlightend laws of science, than in any others whatever.

Absurd and ridiculous remedies were still in vogue in the time of Sibbald. In one instance, he recommends the foam of a horse, taken fresh from its mouth, and mixed with oil of roses, as a cure for the ear ache. In another, the liver of a mad dog eaten cooked, as a preservative against the fear of water. Again he prescribes the skin of a mad dog in the same rabid state, prepared with galls and alum, as a preventive against the gout.

We do not think, that *as a science*, Natural History owes much to this work; and it is not only an instance, how little can either be accomplished without *fixed* principles; but also of the many errors into which any one must fall, who for himself neglects to reflect upon his own observations. It is interesting to observe the then medical condition of Scotland, when so few appeared to see for themselves whatever is either beautiful or excellent in the world around them, and to form conclusions from their own experiments and remarks. He who has succeeded in exciting a more general attention to any given subject, has opened the way to improvement. When men are once induced to think, some will both reason correctly, and strike out new ideas. The great

difficulty is to fix their attention, and to give it a particular direction; this once done, the rest must naturally follow.

On the patronage of the public, the progress of science must necessarily depend. If no one will buy books, none will write them, and where there is no reward, there will be no laborers. If we *as a nation* aspire to eminence in science, and thus to command the respect of the world, we must *as a nation*, cherish every species of scientific investigation, and the talents by which they are sustained.

A nation is but a collection of individuals, and consequently a degree of this responsibility falls upon *each person*, in his own appropriate sphere. The aggregate of grains of sand forms the beach of the sea, and each globule of water contributes to form the resistless wave, that breaks on the shore. It is true that ardent minds, impelled by their own innate energy, will sometimes advance in science without assistance, and that thus talents of a high order and peculiar cast, may force their way into notice, notwithstanding all discouragements and difficulties; and being wholy dedicated to one subject, will finally achieve great results. Intense desire may produce intense action; but minds capable of such excitement and energy are rare; and it cannot be doubted, that had they been encouraged by efficient aid, and warmly cherished by favor, they would have attained still more noble ends. The strength which would carry them successfully through their journey, is spent in overcoming the difficulties that thicken in the early part of the way. But all the various degrees of mental power are necessary in science; sound and unpretending as well as brilliant minds may be usefully employed. Most men will however, labor only on such subjects as promise them final rewards. Even genius may encounter peculiar discouragements; and, necessity often directs its efforts to such pursuits as are most in request among mankind. It is probable, that even of those few who have, perseveringly labored against hope, there was not one whose imagination did not hold out to him, however delusively, honor, emolument or posthumuous fame, as his exceeding great reward; nor perhaps could he without this support have continued to struggle with opposing difficulties.

This country is full of active minds, and science commands a portion of them to labor in its cause. The names of Wilson, Bar-

tram, Audubon, Say,* Conrad, Nutall and many others testify to our successful cultivation of Natural History, and the works which have been published within the last few years in the United States, evince an increasing taste for natural science.†

We now come to a new era in Natural History.

In 1735 Linnæus published in Sweden the first edition of his '*Systema Naturæ.*' The great and most obvious improvements which he made, were the introduction of the binomial nomenclature, and the natural classification of all departments of nature, —beginning with man and gradually descending as he could trace similitudes. And here he appears to have had some idea, but which he did not live fully to elucidate, of the circular theory, since brought more clearly into notice by Mr. Mac Leay, Mr. Vigors, and Mr. Swainson, of London.

The discovery of new truths is the peculiar province of an original genius. Linnæus, absorbed in the studies of nature, carefully reviewed all former systems, thus laying his foundations deep; and collecting what he held to be true in each, he then digested, rearranged, modified, and invented, according to one general plan. As the greatest genius is unavailing without strenuous industry, Linnæus labored incessantly either in his closet or in the fields. The grandest as well as the most correct views, are those which have been gained by minute observations, and by the application of all the more precise and accurate methods of study. He regarded all Nature as a grand unity, infinite in detail, but consistent in execution and end; and with Bacon for his guide, he examined each

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* The greater part of his library and collections he left, on his death, to the Academy of Natural Sciences in Philadelphia. We are truly glad to find a late English writer speak as follows of this really excellent man: "How few form an adequate idea of that ardent zeal, that untiring energy, that perserverance under the most depressing circumstances, that indefatigable industry in collecting, that laborious accuracy in describing with precision and clearness; and above all, that high moral worth, that kindness of heart and gentleness of disposition, which make Say the object of veneration to all who knew him, and cause his memory to be cherished with fondness by all who had once the happiness of calling him their friend." Doubleday, in Mag. of Nat. Hist., No. xxvii, new series.

† Among the signs of this, which we rejoice to see, may be named the increasing demand in our great cities, and even in our smaller towns, for lectures. "Not, as Dr. Channing justly observes, that these and other like means of instruction, are able of themselves to carry forward the hearer;'but they stir up many, who, but for such outward appeals, might have slumbered to the end of life." And they not only do, as we find by experience, impel many on to deeper research, but they are forming an elevated national taste.

species by itself, with the double view of noting its own peculiarities, and its connection with the one great whole.

If, as has been said, he took the first hint of his zoölogical system from Ray, and if he owes to Aristotle and Aldrovandi many of his materials, he yet claims the praise of originally elucidating and fixing the most important principles of nature. What the inventor of the watch owes to the miner, and to the worker in metals, and to him who first observed the elasticity of the steel spring, so much does Linnæus owe to those who preceded him. The material world lay before him, and he made himself its master.

As regards England, his influence was at once perceptible and became ultimately very great. His pupils dispersed themselves over the world to collect specimens, and with their master's science extended both his fame and their own. The Travels of these students were translated, and given to the British public as early as 1771. The *Amænitates Academicæ** were quickly printed both in Holland and Germany, parts of them, being translated, were published in England. A new interest in Natural History was thus created. It became not only the amusement of men of leisure, but the diligent pursuit of the learned; and Societies and Professorships were everywhere instituted for its promotion. The *Systema Naturæ* now became the universal Text Book, and having been enlarged, although perhaps scarcely improved, by Professer Gmelin, it was used as a basis by contemporary and subsequent writers. In 1778 Linnæus died, having produced a greater and more lasting effect upon the mind of Europe, and having roused in the world with more effectual energy than perhaps any literary man had ever done before or has done since.

From this period we may date the *general* establishment of museums in England.* We do not mean to say there were no museums previous to that period. The first on record was formed about 1650, by John Tradescant, who was either a Fleming

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* The following extract from the paper '*Cui bono*,' now rare, contains a fine, and, for those times, a very enlarged view of the subject :—

"Tandem quoque ex contemplatione rerum creatarum, visuri sumus, quod omnia creata ad nostram utilia sint necessitatem, licet non immediatè, sed sæpè per secundum et tertium. Immò ita, quod maximè nobis nocere putamus, sæpe plurimum nobis expediat. Absque his vita nostra longè nobis difficillima, adeo ut, si cardui et spinæ non crescerent, terra nostra multò esset sterilior, &c.

or a Dutchman, and Gardener to King Charles I, of England. He travelled over a great part of Europe and Asia Minor, and into Barbary, Greece, and Egypt; chiefly with a view of improving himself in natural science. He introduced a considerable number of exotic plants into England, and was the first to prove that they might be rendered useful, and made to thrive by due cultivation. He was followed in his pursuits by his son, John, who inherited the museum, and to which he made considerable additions. On his death it was sold to Mr. Ashmole, "the greatest virtuoso and curioso that was ever known or read of in England." We may form some idea of what it contained from the "*Museum Tradescantianum*," a catalogue of it, published in 1656, and which is divided into the following heads: 1. Birds with eggs. 2. Four footed Beasts. 3. Fish. 4. Shells. 5. Insects. 6. Minerals. 7. Fruits, Drugs, &c. 8. Artificial curiosities. 9. Miscellaneous curiosities. 10. Warlike Instruments. 11. Habits. 12. Utensils and household stuff. 13. Coins. 14. Medals. Isaac Walton likewise makes mention of some of its contents in his *Complete Angler* (part I, chap. I). "I know we Islanders are averse to the belief of these wonders; but there be so many strange creatures to be now seen, many collected by John Tradescant, and others added by my friend, Elias Ashmole, Esq., who now keeps them carefully and methodically arranged at his house at Lambeth, near London, as may get some belief of some of the wonders I mention. I will tell you some of these wonders that you may now see, and not till then believe, unless you think fit. You may see there the Hog-fish, the Dog-fish, the Dolphin, the Coney-fish, the Parrot-fish, the Sword-fish and not only other incredible fish, but you may there see the Salamander; several sorts of Barnacles; of Solan Geese; the Bird of Paradise; such sort of snakes, and such birds' nests, and of so various forms, and so won-

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* Reamur, the celebrated French Naturalist, was the first person who formed an extensive collection of animals in France. He was born in 1683 and died in 1757; so that the era of Museums in that country was nearly the same as in England. The well known Brisson, who was the keeper of his Museum, derived from it the principal materials for his work on quadrupeds and birds. These last afterwards constituted the basis of the Royal Museum at Paris. The earliest considerable Museum in this country owes its origin to the late Mr. Peale of Philadelphia. In this museum was first seen a complete skeleton of the mastodon. Many of Wilson's birds, and not a few of the animals procured in the Rocky Mountains, being also there, it has become classical from the frequent reference to these and other specimens.

derfully made, as may beget wonder and amazement in any beholder," &c. The Dodo was preserved in this collection. Mr. Ashmole presented the whole to the University of Oxford, where it still remains; and it has of late been much enlarged by the munificence of its present Curator, Mr. Duncan.

The next collection was Dr. Woodward's, which became the foundation of Sir Hans Sloane's; and the whole was purchased, in 1753, by the British Parliament, and is now known as the British Museum. Another collection, once much celebrated, was that in possession of Sir Ashton Lever,* who died in 1788, and which was sold by auction in lots, and dispersed in 1806.

But still museums were very far from being common or popular in any part of Europe. London was, at the period we refer to, as now, a place of general resort for scientific men, and a large number of such persons were collected there. The celebrated Bishop Horsley, the learned and able antagonist of Dr. Priestley, was an active member of the Royal Society. Sir Joseph Banks, possessing the advantages not only of great abilities, but of fortune and a high station in society, constantly exerted himself in this cause. He and his friends, convinced that without extensive collections it is very difficult, if not altogether impossible, to make any great progress in Natural History, were diligently employed in forming Societies, and in collecting specimens for examination from different countries. The eminent men of that day, likewise deeply felt the importance of bringing together those who pursue the same studies, and they understood that, especially in physics, union is power; that the first thoughts and more transient discoveries of individuals, made known to a circle of scientific friends, may, and often do, both save the labor of many, and draw out the energies of many more, and that particular subjects being alloted to different observers, on the principle of the division of labor, the examinations are more exact and availing. The Royal Society had already proved the advantages of such meetings. We owe very much to the publication of their '*Transactions*,' in which, each contributing a little, where otherwise none would have contributed at all, the result is an immense mass of facts, thoughts, and experiments. And indeed the British Association for the Ad-

* For a notice of this museum, see Journal of Travels in England, &c. 1805–6. Vol. I, by B. Silliman.

vancement of Science may be said to be but the carrying out of this principle on a grander and more enlightened scale.*

In this country much has been done both in forming scientific and popular museums and societies. It must, however, be allowed that few of our societies are efficient, and too many exist only in name; but the Philosophical Society, the Academy of Natural Sciences, of Philadelphia; the Lyceum of Natural History, of New York; similar institutions in Baltimore and Charleston; the American Academy, and the Natural History Society, of Boston; the Institute, of Albany; the young Natural History Societies of Salem† and Yale College; and a still more youthful Society in Harvard University, evince that all are not asleep, or in a state of suspended animation. Several of these institutions have valuable collections, most of which are rapidly increasing. Among the most distinguished, are those of the Academy of Sciences and the Franklin Institute, of Philadelphia; of the Lyceum of New York, and the Natural History Society, of Boston.

Among our popular Museums are several of great merit in our principal cities, at the head of which is deservedly placed the fine museum of the late venerable Peale—with its colonies in other cities,—and several others, in all our larger towns.

Our living Naturalists are numerous. Audubon, Nuttall, Harlan, Morton, and Torrey are not without coadjutors, and it would require a long catalogue to enumerate them all. The early publication of Wilson's Ornithology, with its continuation in later years, and of Holbrook's Herpetology, still going on, affords sufficient proof that this country is alive to the claims of Natural History.

The next great writer upon British Zoölogy is Thomas Pennant. We should wish to depict Pennant's character as that of

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* Among the earlier collections formed in England, the Wyckliffe Museum may be particularly noticed as one much celebrated in its day. It was formed and owned by Marmaduke Tunstall, an independent gentleman, of old family, at Wickliffe, in Yorkshire. He was the friend and correspondent of the greatest naturalists of the day. To this collection the writers of those times owe much; and from unique specimens contained in it, Edwards, Brown, Pennant, Latham, and Bewick, illustrated their works. At his death it was sold; and having passed through the hands of Mr. Alian, of Darlington, in the county of Durham, it became in 1822 the foundation of the excellent collection in Newcastle upon Tyne, where it still remains.

† The East India Museum of Salem is an unique and most interesting collection; and the Chinese Museum at Philadelphia, although having little relation to science, is rich beyond all example, in illustrations of China.

a man, a father, and a Christian, (for as such he appears eminently to have fulfilled his duties,) rather than as merely a literary and scientific person; but unfortunately our materials are very scanty. The chief source from which all the biographies of Pennant have been drawn, is a work which was published by him in 1793, under the fanciful idea of writing after his death, '*The Literary Life of the* LATE *Thomas Pennant*;' and which contains a few circumstances of his private life, and peculiarly shows the bent and tone of his mind.

He was born in 1726 at Downing, in Wales. His family was old and respectable, possessing some landed property, and having for some generations held honorable situations under Government. He appears to have been an only child. When properly prepared, and at the usual age, he entered Queen's College, Oxford; but afterwards he changed to Oriel, and on taking his degree, assumed the law gown. He is here described as conspicuous for his general intelligence, and for the progress he made in classical knowledge. But his taste for Natural History was formed at a very early period, and long before he was able to indulge it to the extent which he afterwards did. It is, indeed, not uncommon that those who, when young, have evinced a taste for this science, neglect it altogether in after life; their feelings being, in this respect, like those of children pleased with the first sight of a beautiful object. It is extremely rare that a person who has neglected this study in youth, becomes fond of it in after years. Pennant says, "a present of the Ornithology of Francis Willoughby, when I was about twelve years of age, by my kinsman, John Salisbury (father of Mrs. Piozzi, known as the Biographer of Dr. Johnson,) first gave me a taste for that study, and incidentally a love for Natural History in general, which I have since pursued with my constitutional ardor."

On leaving college he probably returned to his home, and there pursued his studies in the law. In these, however, he never made much progress. His station in life was one which is, perhaps of all others, the least adapted for nourishing common ambition, or for stirring up a person to diligence in the business of life. It was a saying of the late Lord Eldon, that if a man be desirous of rising to eminence in the legal professon, he should be dependent solely upon his own endeavors for a maintenance. Now the contrary was exactly Pennant's case. He knew that he

should inherit a handsome property on his father's death; and in the mean time his allowance was such, that while it afforded him a comfortable competence, it prevented his indulging in luxuries; or seeking, in a more expensive sphere, for a higher standard of mind and action. The law he never practiced; and a few years after leaving college, he married, and settled down as a quiet country gentleman. It was not till he was about forty years of age, that he came into possession of his patrimony. His mind however, was naturally active; and he was constantly employed in laying a foundation, in other studies, for his future eminence in the walks of natural science. Intimate social intercourse he appears particularly to have enjoyed. He was far from shutting himself out from the society of his friends; he mixed freely with such as his neighborhood afforded; and with the marked politeness of the old school of manners, he highly relished the company of the fair sex. He has left a few sonnets of his own composing, which he addressed to particular ladies; and while the verse is neither very polished, nor manifests much study or care, the whole is marked by a pleasing playfulness of fancy; an enlightened conception of the beauties of nature, (the constituents of poetry,) and a high moral delicacy. During this time, his attention seems to have been turned to the practical and economical uses of natural science; and he thus refers to the subject in his preface to *British Zoology*;—"At a time when the study of natural history seems to revive in Europe, and the pens of several illustrious foreigners have been employed in enumerating the productions of their respective countries, we are unwilling that our island should remain insensible to its peculiar advantages; we are desirous of diverting the astonishment of our countrymen at the gifts of nature bestowed on other kingdoms, to a contemplation of those which (at least with equal bounty) she has enriched our own. Why then should we neglect inquiring into the various benefits that result from these instances of the wisdom of our Creator, which his divine munificence has so liberally and so munificently placed before us?"*

* The study of the *economical uses* of natural history has been, hitherto, very little cultivated, and requires more general attention. As a true science it has, of course, an *art* in natural connection with it; and the full elucidation of this art is still wanting. The most obvious application of it is to agriculture, taking the word in its widest sense; but there is scarcely a physical subject of ordinary occurrence which might not be more or less indebted to it. The distribution of

Previous to 1757, his only publications of consequence were two papers in the Philosophical Transactions. In that year, Linnæus seeing one of the productions, was so much pleased with it as to procure his election as a member of the Royal Society of Upsal; an honor which appears to have had its appropriate effect upon his mind, in stirring him up to still greater endeavors; and this is indeed, the principal benefit of such literary distinctions. In 1761, being then thirty-five years of age, he began his first great work on *British Zoology.* It was published in folio at his own cost, and contained one hundred and thirty-two plates.

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shell-fish and other animals, of reptiles, and insects; the various important duties which they perform in the economy of the world; and the possibility of procuring their assistance, or avoiding their ravages, are all subjects which have been very slightly investigated. As a singular instance in point, we may mention the cultivation of figs in the island of Malta: "The peculiar process in the treatment of this fruit, is worthy of remark; and the necessity of its adoption in some countries, to the exclusion of others, is a subject which the curious may find interesting to determine. Where the figs are advancing towards maturity, in order to prevent their falling off, and to hasten their ripening, a cluster of male figs is suspended upon the branches of the female tree, by means of a plant, (*Ammi majus,*) which effectually secures them from the danger, and soon effects the desired end. Many small winged insects are generally found in the male fruit upon opening it. The most rational way for accounting for this effect is, that these small flies, entering into the male fig, yet clothed with the pollen with which the stamina on the inside are covered, and carrying it with them into the female fig, produce that natural coalition which is necessary for the effectual generation of the fruit." Again, the production of cattle and birds for food, is a portion of the *art* of natural history, and requires farther study. A society, which promises to be successful in its results, has lately been established in London, on this principle, for the introduction in the poultry yards of various animals and birds which have hitherto been neglected. Again, much improvement in some branches of mechanics might be expected from an accurate investigation of this subject. The writer contributed a few years since, an anonymous article to this Journal, (Vol, xxxii, pp. 73, 235.) on the "*Economical uses of some species of Testacea,*" with the view of showing that even in a branch generally supposed to be least capable of any practical benefit, this principle might be much extended, and greatly carried out; and if so, that then in others, universally confessed to be more capable of it, it need not to be neglected for fear of failure. Natural science is, still, too little considered as a *whole.* It cannot be said by any means yet to have arrived at its climax; but when it is perfected, it will, it appears to us, combine in one grand circle, natural systematical arrangement, founded on anatomical distinction; a minute description of the generic, individual and social habits of each species; a knowledge of the uses to which they may be made available; the purposes of their creation, and the place which each holds in the great chain of nature; a vast mass of materials has been indeed collected; but much is still wanting to finish so great a work. Nature is still viewed not as a whole, but only limb by limb; and the next great marked improvement in this science, will probably be the conjunction of the different parts into one general intimate union; and the combination of the science with the art.

The profits of it he had dedicated to a Welsh charity school in London, of which he was the patron; but the expense of the undertaking was so great, and the sale comparatively so limited, that he lost considerably by the work. As the editions were multiplied he added to it, and improved it; and it was afterwards published in octavo with profit. The first one hundred pounds that he realized from it, he presented to the school. Two years after this, his wife, to whom he appears to have been much attached, and of whom he speaks in the warmest terms of affection, died; leaving him two young children; and to relieve his mind from the grief natural to such an event, he paid a visit to the continent.

We may imagine with what pleasure Pennant, with a mind constituted as his was, found himself surrounded by the great naturalists and literati of his day. Among them he visited, and became intimate with Buffon, Voltaire, Baron Haller, the two Gesners, and Dr. Pallas. The intimacy thus formed, with Pallas, continued through life; their correspondence was frequent; and Pennant tells us that to this gentleman he owed the first hint of his *Synopis of British quadrupeds.* But Buffon was then the most noted naturalist in that part of the continent; and naturally therefore, the person in whom Pennant felt the greatest personal interest. He spent a week with him at his country residence. Buffon was born in 1707, of a noble family, and at an early age inherited a large property. He dedicated his life to the pursuit of science. In 1749 he began to publish his "*Histoire naturelle,*" and completed it in 1767. He died about 1780. His talents were original, and of high order; and by the beauty and eloquence of his style, the earnestness with which he insisted upon the advantages of this study; and the magnificence of his published works, he attracted great attention to the science. As a *practical* naturalist, he was, however, exceedingly deficient. He depended in a great measure upon the information afforded by others; and like Goldsmith, in a somewhat similar undertaking, his brilliant imagination worked this up into an interesting and most popular book. He pursued no regular system, although he had his own peculiar views. Whether he already saw the danger which was likely to arise from too servile an adherence to Linnæus; or whether it was owing to a want of sufficient knowledge of scientific detail; and an affected independence of mind, he merely grouped his

subjects according to a coarse, outward resemblance; and ridiculed a more accurate system of classification.

The mind of man is ever more inclined to follow some one leader, and to lean upon the labors of others, than to strike out truths for itself. Thus it has always happened, that a fondness for certain popular systems has chained down the general intellect to one point. Buffon perceiving the popularity of the writings of Linnæus, foreseeing to what it would lead, and endeavoring to avert this evil, in this way rushed into the contrary extreme; he thus discarded all system but what *he* chose to call the natural one, "*ne seroit—il pas*," says he, "*plus naturel, et plus vrai de dire qu'un âne est un âne, et un chat, un chat que de vouloir, sans savoir pourquoi, qu'un âne soit un cheval, et un chat un loup—cervier?*"

On Pennant's return home in 1767, he was elected a fellow of the Royal Society; and in 1768, we find him engaged in publishing a second edition of his British Zoology. Like Ray, he was, throughout life, celebrated for his frequent tours through Great Britain, accounts of which he published from time to time. His object in these journeys was to study natural history in the different parts of the country; but he paid attention to every thing of interest; and especially to antiquities. In 1770 he visited Scotland, with the condition of which, strange as it may seem at the present day, the English were then almost unacquainted. "I had the hardiness," says he, "to venture on a journey to the remotest part of North Britain, a country almost as little known to its southern brothers as Kamtschatka. I brought home a favorable account of the land. Whether it will thank me or not, I cannot say, but from the report I made, and showing that it might be visited with safety, it has ever since been *inondée* with southern visitors." In 1772, he made another visit to that country, and went as far as the Hebrides. His only companion in these journeys was a self taught artist, whom he supported, and who illustrated his different works with views, engraved in a very excellent style. Besides these trips to Scotland, he visited Ireland, as well as the north of England and Wales, and published an account of the Topography of London. All these tours he performed on horseback; a mode of travelling to which he attributed the excellent health which he enjoyed through life. By thus moving about, he acquired much information for his va-

rious works; and he discovered many novelties, which perhaps were novelties only, because no one had hitherto taken the trouble to look for them. Since his day, England has been diligently explored, and he is fortunate who succeeds in discovering there any thing new. In this country there is altogether as good a field, if not better, for original discovery, as Pennant enjoyed; and the experience of our travelling naturalists and of the scientific and exploring expeditions proves sufficiently, that he who takes the trouble of observing, will be fully rewarded for his pains. The accounts which Pennant published of these tours, are perhaps the most instructive and interesting of the kind which we possess.

It is a common remark, that the climates of both Europe and America are gradually changing. To decide whether this is the case or not, or whether the difference arises only from a higher state of cultivation, is a work of great difficulty. The data on which to proceed, are in a great measure wanting. Well conducted meteorological observations, although we now have some of great value, have not been recorded in numerous places and for a sufficient length of time, to form the basis of general conclusions; and without some such certain and well known experiments, from which sound deductions may be drawn, it is not possible to arrive at any satisfactory opinion.

It is a circumstance worthy of observation, that both in the United States, and in Great Britain, many birds appear to have changed their habitations within the last one hundred years. In his first tour to Scotland, Pennant visited the Fern Islands, a group of barren rocks off the Coast of Northumberland, and there found the little Auk, (*Mergulus alle*, Selby,) and the Black Guillemot, (*Uria Grylle*, Lath,) not unfrequent; while, according to Mr. Selby, the first does not now occur at all, and the latter is only occosionally met with in that location. Another instance is that of the Crane, (*Grus cinerea*, Bechst.,) which, according to Ray, was in his time found, in some counties, in large flocks, but which now ranks among the rare visitors. Others again, once scarce, have taken their places, and become comparatively common; among which we may particularly remark, as of very recent date, the Honey Buzzard, (*Buteo Apivorus*, Ray.) A long list of such changes might be given. We must now revert a few years, to trace Pennant's literary labors.

In 1769, he published a volume on British fishes; and in the same year he began a work on *Indian Zoology*, which however, proceeded only to twelve plates, and was afterwards republished in Saxony. Of this he observes:—"my mind was always in a progressive state; it could never stagnate; this carried me further than the limits of my own Islands; and made me desirous of forming a zoology of some distant country, with which I might relieve my pen by the pleasure and variety of the subjects." In 1770, he was elected a Fellow of the Royal Academy of Drontheim. In 1771, the honorary degree of doctor of law, was conferred upon him by the University of Oxford. About this period, he married a second wife; the fortune he now possessed, allowed him to indulge his natural taste for hospitality; and being thus comfortably settled, he entirely lost, as he informs us, his desire of rambling. In 1785, appeared his great work on the "*Arctic Zoology;* which was shortly after translated both into German and French. He was now elected a member of the American Philosophical Society of Philadelphia, an attention which was peculiarly gratifying to him; and he observes on the occasion, that "there science of every kind began to flourish, and among others of natural history."

From this time he continued to print other occasional works; among them a pamphlet entitled, '*American Annals; an incitement to Parliament men to inquire into the conduct of the commanders in the American war;*' and he was now much engaged in his duties as a magistrate and a landlord. His health continued good till within two years of his death, when, in 1798, he quietly sank into the grave at the age of seventy-two. In person he was rather above the middle height, well proportioned, and somewhat inclined, in the latter part of his life, to corpulency. His complexion was fair; and his countenance peculiarly open and benignant.

While many may stand higher in general estimation for their genius and abilities, few surpass Pennant in his unceasing industry and his continual endeavors to be useful to his fellow men. Mild and amiable in temper he avoided politics as far as he could, in an age peculiarly subject to political excitement; and this, refined a disposition originally tender and gracious. He fulfilled his domestic duties in a manner truly exemplary; and his writings abound in passages which prove that he never forgot his con-

stant dependence upon his Creator. The distresses in which his poor neighbors were involved, gave him unfeigned uneasiness; and he endeavored to relieve them by every means in his power. His name was long remembered by them with love and respect. But we cannot do better than to let him speak for himself, as regards his occupations and character. "I still haunt the bench of justices (1793). I am now active in hastening levies of our generous Britons into the field. However unequal, I still retain the same zeal in the services of my country, and have grown indignant at injuries offered to my native land; or have incited a vigorous defence against the lunatic designs of enthusiastic tyranny, or the presumptuous plans of fanatical atheists to spread their reign or force their tenets on the contented moral part of their fellow creatures." "I am often astonished at the multiplicity of my publications, especially when I reflect on the various duties which it has fallen to my lot to discharge, as a father of a family, landlord of a small but very numerous tenantry, and not an inactive magistrate. I had a great share of health during the literary part of my days: much of this was owing to the riding exercise of my extensive tours, to my manner of living, and to my temperance. I go to rest at ten; and rise, summer and winter, at seven; and shave regularly at the same hour. I avoid the meal of excess—a supper; and my soul rises with vigor to its employments, and I hope does not disappoint the end of its Creator." "Thus far has passed my active life, even to the present year, 1792, in which I have passed half way of my sixty-seventh year. My body may have abated its wonted vigor, but my mind still retains its wonted power, its longing for improvements, its wish to receive new lights through chinks which nature has made."

In his zoölogical works he includes the whole of the British vertebrated animals—*testacea*, *crustacea*, &c. His arrangement is founded upon that of Linnæus; but he occasionally alters his plan to that which seemed to him better adapted to the subject. instead of confining himself to mere description and classification, which was a prominent fault in previous works on natural history, and one which has not been avoided by succeeding British Naturalists, he, as far as he is able, both introduces notices of habits and manners, and indulges in detail. His writings are still considered as standard works, and are still constantly referred to and quoted. In some departments, very little has since been added,

but of course in the more intricate subjects we can scarcely expect to find him perfect. The plates are numerous, and executed with great fidelity. Those of the Testacea have seldom been surpassed. From his life we may learn that the busiest station does not preclude attention to this study; and while it relieves and graces narrow circumstances, it adds increased lustre and honor to the highest stations.

The British Conchologists of this period were Emanuel Mendes da Costa, who published at London, in 1778, a very beautifully executed quarto volume under the title of '*Historia naturalis Testaceorum Britanniæ; or the British Conchology, containing the descriptions, and other particulars of the Natural History of Great Britain and Ireland.*' The plates are very faithful, and are colored. The text is both in French and English. His system was peculiar to himself, and has never been adopted. It was in conformity to a system which he had proposed shortly before in a thin octavo volume, called 'Elements of Conchology.' His work is still often referred to for the plates.

The other writer, who is less generally known, is Walker, who published a volume in 1784, on the intricate subject of the minute British Shells. '*Testacea minuta rariora.*'

Ten years before Pennant's death, in 1788, appears the first edition of Rev. Gilbert White's '*Natural History and Antiquities of Selborne*;' a work which ever has been, and ever will be, read with pleasure. Born in 1720, at Selborne, a little country village, the surrounding scenery diversified with hills and woods, he passed through the ordinary routine of education; and in due time became a Fellow of Oriel College, Oxford; and one of the Senior Proctors of the Univerity. "Being of an unambitious temper, and strongly attached to the charms of rural scenery, he early fixed his residence in his native village, where he spent the greater part of his life in literary occupation, and especially of the study of Nature. This he followed with patient assiduity, and a mind ever open to the lessons of piety and benevolence which such a study is so well calculated to afford. Though several occasions offered of settling upon a college living, he could never persuade himself to quit his beloved spot, which was indeed a peculiarly happy situation for an observer. He was much esteemed by a select society of intelligent and worthy friends, to whom he paid

occasional visits. Thus his days passed tranquil and serene, with scarcely any other vicissitude than those of the seasons, till they closed at a mature age, on the 26th June, 1793." His work, consisting of letters addressed to Mr. Pennant, and which, in the original edition, is a thick quarto volume, illustrated with plates, is a singular instance how much may be effected in a very small sphere by a joint habit of observation, and of noting down every thing as it occurs. We lose constantly many interesting particulars, from neglecting to make a memorandum of them at the time; they may at the moment appear to be of very slight importance, but each year will add to their value, and each separate circumstance connects the foregoing with some general principles. He who tries this plan is soon surprised to discover what a large mass of curious information he brings together. It is the foundation of the success of fictitious writings, that human nature, depicted exactly as it is,—the manners and sayings either of individuals or great classes of men, faithfully recorded—always prove highly interesting and popular. This, if the description be but graphic and faithful, is equally true as regards the habits and instincts of the inferior creatures; and what White did, all persons of any literary taste are equally capable of accomplishing. As a clergyman, confined to his parish, which he seldom appears to have left, and diligently engaged in his duties, the only time in which he could indulge this taste, was during the hours of relaxation and exercise; and having once attained the habit of daily making notes, the time required for doing so was very little and such as every one has at his disposal. It is to such observations, rather than from the labors of professed naturalists, that for the present at least, we must look for the progress of natural history in this country. We must depend upon individual effort for combined results; and it is an encouragment that one need not be an accomplished naturalist, or one by profession, in order to make useful observations. Pennant, in a short essay attached to his zoölogy, has particularly pressed the attention of clergymen to this study. There certainly is no reason why they should neglect, and there are many cogent reasons why they should cultivate it. Country clergymen often enjoy many facilities for its successful prosecution; while classical knowledge and literary habits render them peculiarly fit for making discoveries and

improvements. It falls in very happily with their professional knowledge. The mysteries of the creation of God, as well as his attributes, and his government of the world in his dispensations to man, it is their duty to study and to exemplify; but while they confine themselves to the revealed word alone, they shut out of sight a volume which speaks not less forcibly of the love and excellencies of the Creator, and of his mighty wisdom and perfections. There is no reason why persons of this profession should be less sensible to, or less well informed in regard to physical objects, than the other educated classes of society, but rather the contrary; and the greater their knowledge is, the greater likewise will be their capabilities of fulfilling the end of their lives. The Jesuits,* whose system of education is perhaps, as a means, one of the very best adapted for producing the required results, are very far from neglecting the study of these subjects; and they have exemplified in practice, what the good George Herbert has asserted in theory, that "the country parson is full of all knowledge. They say it is an ill mason that refuseth any stone: and there is no knowledge but in a skilful hand,—serves either positively as it is, or else to illustrate some other knowledge. He condescends even to the knowledge of tillage and pasturage, and makes great use of them in teaching, because people, by what they understand, are best led to what they understand not."†

Some of the greatest living naturalists of Great Britain are clergyman, among whom we may mention Dr. John Fleming, minister of Flisk, Fifeshire, Rev. Leonard Jenyns, and Professors Buckland and Sedgwick, to whom Geology owes much of its present eminence.

The following extracts from White's original preface, are not unworthy of repetition:—

"The author is also of opinion that if stationary men would pay some attention to the districts in which they reside, and would publish their thoughts on the objects which surround them, from such materials might be drawn the most complete county

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*"Sic etiam quoniam artes, vel *Scientiæ Naturales* ingenia disponunt ad Theologiam, et ad perfectam cognitionem et usum illius inserviant, et per seipsas ad eundem finem juvant; qua diligentia par est, et per eruditos Præceptores, in omnibus sincere honorem et gloriam Dei quærendo, tractentur."

*Constitutiones Societatis Jesu.* 1558. *Pars* 4. *Cap. XII.* § 3.

† "A Priest in the Temple." Chap. IV.

histories which are still wanting in several parts of this country."* "If the writer should at all appear to have induced any one of his readers to pay a more ready attention to the wonders of creation, too frequently overlooked as common occurrences; or if he should, by any means, have lent a helping hand towards the boundaries of historical and topographical knowledge, his purpose will be fully answered. But if he should not have been successful in any of his intentions, yet there remains the consolation behind, that these pursuits, by keeping the body and mind employed, contributed to much health and cheerfulness of spirit, even to old age."

But while writers were thus arising on all sides, and were diligently employed in illustrating the zoölogy of their own country, this science could not yet be said to have become, in the proper sense of the word, *popular*. Illustrated books are peculiarly necessary in the pursuit of this study. Such were still expensive, and difficult of attainment. The works of Linnæus were still concealed in the Latin tongue; and the majority, those for whom such a refining study is chiefly to be desired, were thus shut out from the most efficient means of acquiring a philosophical knowledge of the subject. This difficulty was now to be removed.

In 1790, Thomas Bewick first appeared conspicuously before the public, both as a naturalist, and the reviver of the art of engraving on wood; and we may justly be allowed to consider the publication of his works as an era in this science, so far as it rendered the subject more easily available to the mass of the people. In this year came out the first edition of his '*General History of Quadrupeds*;' a book which went through nine editions before the year 1824. Although he does not confine himself to British animals, he gives, with his usual accuracy of delineation, engravings of all the species which were then known. The improvement, however, which he afterwards made in his art, will be readily observed by those who compare his earlier style in this work, with the softness and spirit which characterize his birds in the later editions. Thomas Bewick was born in 1753, at Cherryburn, in Northumberland. His parents were far from being ill

* The intelligence, accuracy, and fullness of Sir John Sinclair's great work, '*The Statistical History of Scotland*,' are well known. It was formed on this principle, and the account of each parish and district contributed by its respective minister.

affluence, and moved in a humble although respectable station of live. At an early age he was sent to a dame's school, and he afterwards completed his English education under a better instructor. Here he strongly manifested his love for the picturesque, and his taste for drawing. So evident, indeed, were those traits of character, that his father was induced to bind him, at the age of fourteen, an apprentice to a copper-plate engraver, at Newcastle upon Tyne. Of this part of his life nothing particular is known, except his dislike to his business, which was chiefly the coarse and dirty work of cutting brass dial-faces for clocks; but he appears to have worked industriously, and to have been steady and diligent in his habits. In 1770 he first proved his talents for wood-engraving, while his employer was engaged in executing the cuts for *Hutton's Mensuration.* The mathematical diagrams requiring greater correctness than could be attained by the use of the ordinary chisel, he invented a double-edged instrument which answered every purpose in making a very fine and straight line. His attention once turned in this direction, he made rapid progress. Till 1787 he was employed in illustrating some volumes of fables, and other small books; and, as in such works, birds and animals were the frequent subjects of his graver, he acquired an excellent accuracy in their delineation. By degrees he improved. With this progress he made new experiments and inventions, and with the growing facility of execution, his mind was daily more fixed upon his subject.

In 1786 he was married; and in 1789 he published his celebrated print of the Chillingham wild Bull, the largest and most highly finished wood engraving which he ever executed.

In 1790 he published, as we have said, his work on quadrupeds; and in 1797, after nearly six years of constant labor, the first volume of his '*British Birds*' appeared. After the lapse of nearly a similar period, in 1804, the second volume, that on water birds, was presented to the public—the whole term proving, if any proof were wanting, his great perseverance, and that the work was not hastily nor crudely executed. The book went through six editions before 1826. The Wycliffe or Tunstall Museum, of which we have already made mention, was the occasion of this popular work; for Mr. Tunstall perceiving Bewick's great abilities as an engraver, first proposed the subject to him, and offered him all the facilities of which he afterwards made use. While this gentleman lived he was the constant and liberal patron of Bewick.

From this time he was chiefly occupied in adding to, improving, and carrying through the press the various editions of his works on natural history; but he likewise found time to illustrate many smaller and less popular books for the publishers.

He died in 1823, at the age of seventy-five. His character as a naturalist cannot be rated very high. Nearly all that he knew of natural history he derived from the observation of others; and his education had not been such as to prepare his mind for pursuing the subject philosophically. He possessed a strong love for nature, but he expended it, in a great measure, on drawing and engraving the dead specimens. We owe but few original remarks to his works. For the greater part of his life he resided in Gateshead, the suburb of Newcastle upon Tyne, and consequently he had fewer opportunities of personal investigation, than if his life had been passed in the country.

In appearance and character he was not unlike the celebrated Dr. Johnson. Large and uncouth in person, unpolished in his manners, and, at times unpleasantly rough in his demeanor; he was yet possessed of strong good sense; much perseverance and ingenuity; and in all his actions and all he said, there were apparent a sterling warm-heartedness, and a talent for wit and humor which could not fail to please. "When animated in conversation, and he was seldom otherwise, his eye was peculiarly fine, and imparted a vivacity to his countenance very difficult to describe or forget. There was more of intelligent benevolence and candor in it, than I ever saw in another; but it was mixed with an earnest gravity, almost bordering on severity when speaking in disapproval; and with the brightest animation, when discussing the beauties and wonders of nature, or subjects of equal interest. His humanity was very extensive, cherishing continually some scheme for the improvement of his fellow creatures, or the better treatment of the animals intrusted to them. His language was extremely forcible; and the words he made use of, those calculated in the plainest and most familiar manner to convey his meaning; but unfortunately this love of *simplicity*, oftentimes led to a degree of coarseness which no one could hear without reprobating."* His dialect was broad Northumbrian.

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* Mr. George Atkinson, in the *Transactions of the Natural History Society of Newcastle upon Tyne and Durham.*

He mixed a rough, sound good sense, and some times an originality of remark in his conversation, which always rendered what he said interesting. His pleasantries were less remarkable for true wit and delicacy, than for the union of strong sense and honest merriment.

His engravings are distinguished by their extreme fidelity, and for the truth with which he has caught and transferred to paper the peculiar air and habit of his subject; while he reduced it from its natural size to a small wood cut. But his improvements in the art of cheap and correct engraving, have had a much more extensive influence than in natural history. Those who may remember, or have seen the books put into the hands of children during the last century, will perceive how much, in the present day, this all-important class of books owes to Bewick; and how the distorted representations of nature, have given place to correct and graceful figures; and those who reflect upon the variety of subjects which now owe their illustrations to the art, will feel inclined to give Bewick the credit of being truly a benefactor of mankind. He left several children. One of his sons is now an artist of no small ability.

In 1800 appeared Turton's translation of Gmelin's edition of the *Systema Naturæ* of Linnæus. This work is printed in seven thick octavo volumes; but at a comparatively low price; and although it is now fallen both in value and estimation, yet at the time it did great good in opening the science to the mere English reader. It has been accused, and justly, of faults, both derived from Gmelin, and from its own author. Varieties are given as species, synonyms as distinct species, and hypothetical and fabulous animals are occasionally obtruded as existing. Too much dependence was placed upon preceding writers. But considering the vastness of the work; the difficulties to be encountered; and the doubt which hung over many parts of it, it is well executed. It is now of value only to the historian of science, the annalist, or the professed system maker; being as faithful a record of the errors, as of the real science of its period.

William Turton, M. D., was through life, a zealous naturalist; and besides this book, he published some smaller volumes on conchology. His favorite pursuit was the investigation of British shells. His industry and perseverance were great; but his circumstances being narrow, and he not possessing much originality

of thought, he was unable to take a high stand in the scientific world. He died in Cornwall, where he had chiefly resided, about 1834, at an advanced age.

In 1802, appeared the "*Ornithological Dictionary*," of that most industrious observer and writer, Col. GEORGE MONTAGUE, of Knoule House, Devonshire. We have in vain searched for any biographical notice or memoir of him; and it is much to be desired, if materials exist, that some account of his active and scientific life might be given to the public. This work is only upon *British birds;* and the plan is well adapted for reference, as he threw his materials into the form of an alphabetical catalogue. He presents much original information, the greater part of which he collected himself. His object was to render the subject popular; and he appears to have written expressly for "such as might wade through columns, before they could find the object of their inquiry, but who are desirous of being better acquainted with the most beautiful part of the animal creation." He corresponded with the most eminent naturalists of his day. He was the first to observe, *as British*, several birds which had previously been overlooked; among which we remark the *Macroramphus griseus*,* (*Leach.*) of the United States and the *Ardea lentiginosa*, (*Mont.*) which naturalists have hitherto been in the habit of considering the *Ardea minor*, (*Wils.*) likewise of this country.

In 1813, Montague published a supplement to his dictionary, which is nearly as large as the original book. But his great work was that on British conchology, "*Testacea Britannica, or natural history of British shells, marine, land, and fresh water, including the minute*, &c," a quarto volume of upwards of six hundred pages, and published in London, in 1803. This is an invaluable work. As a describer of shells, he probably stands at the head of English writers on the subject; and his book is still unsurpassed. He spared neither pains nor expense in procuring specimens; and he was enabled both to add many new species, and clearly to distinguish between such as had hitherto been considered merely as varieties. In 1808, he published a supplement, in which many new species are given. He follows in general, the Linnæan arrangement, but has made one new

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* Scolopax Novoborocensis, (Wils.)—EDS.

genus, (*Balanus*,) and followed Pennant in some cases in preference.

The only other work of which he appears to have been the author, is entitled,"*The Sportsman's Dictionary, or Tractate on Gunpowder*," which we have never seen. His collection of shells, is, we believe, now deposited in the British Museum of London.

In 1804, appeared the "*Natural History of British shells, including figures and descriptions of all the species hitherto discovered in Great Britain, systematically arranged in the Linnæan manner, with scientific and general observations on each*, by E. Donovan, in five octavo volumes. This is a beautiful work, and was among the first of the kind which was issued in periodical numbers. The figures are the size of life, well engraved on copper, and faithfully colored. The letter press is, however, of comparatively small value; and the volumes are chiefly referred to at present, for the plates. He describes in all, two hundred and nineteen species.*

Shortly after, in 1808, there followed by the same author, "*The Natural History of British fishes, including scientific and general descriptions of the most interesting species, &c.*" This work is likewise in five octavo volumes; and as he appears to have limited it to that number, he excluded many of the commoner species. The figures are one hundred and ten in all, whereas it is ascertained that *two hundred and twenty-six* exist in the British seas and rivers. The work is beautifully executed, and the same remarks as are made on the above may apply to this.

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* The researches of Lea, Conrad, Say, Totten, Morton, Vanuxem, Binney, Couthouy. Kirtland, Ward, Hildreth and others, in relation to our recent and fossil conchology, have disclosed most interesting treasures, and we highly appreciate their labors: while it is still much to be desired, that some general work on the conchology of this country were published; were it but a list of what has already been described, with references to the periodical works in which the descriptions may be found. As it is, the student is without a guide to American conchology. A great variety of transactions and journals must be searched through, to collect the scattered fragments, and as this is in the power of very few, an insurmountable barrier is thrown in the way of farther improvement. Upwards of 600 species, have, we believe, been described as belonging to the United States; the number might, we well know, be greatly increased; but from want of an acquaintance with what has hitherto been noted, every student is at a loss whether to consider the species he may find as new, or at present known. Would not such a work be patronized?

From this period, for several years, we have no great work especially dedicated to *British* Zoology. In 1815, Lamarck, by the publication in Paris, of his *Histoire naturelle des animaux sans vertèbres*, created a new interest in this study, and placed conchology on a new basis; one, however, of which Lister previously appears to have seen the propriety. In 1817, appeared, likewise in Paris, Cuvier's *Regne Animal.* So strong a hold, however, had the system of Linnæus taken on the minds of the British naturalists, that neither of these great works was as cordially received as they ought to have been; and it has required some years fully to attract attention to them; and to show the effect which they have produced on the study of the natural sciences.

While therefore, this study was gradually gaining ground in England; materials were being collected, and many provincial museums and societies, were both formed, and maintained with spirit. We must pass on to the year 1825, when Mr. Prideux John Selby, published the first volume of his magnificent work on British birds. It is in large folio. The plates are drawn from nature; frequently from the living specimen, and are lithographed. Where the dimensions will admit of it, the figures are of the size of life; and all are beautifully colored with much precision and accuracy. Two volumes of letter press accompany this work. These are confined chiefly to the mere description and habitat; nor indeed, however much we may lament that the admirable sketches, which Mr. Selby is capable of giving, should be omitted, was it intended to be otherwise. For he says in the preface, "I have contented myself with referring by occasional notes, to any anecdotes particularly interesting as to the species under consideration." In the first edition of his first volume, he had chiefly followed the natural arrangement proposed by the celebrated French ornithologist, M. Temminck; but finding it to be imperfect, and not adapted to the natural order, at least of British birds, in his second edition he has rewritten the work, and had adopted that system which is proposed by Mr. Vigors.

Mr. Selby is living, and is still ardent in his favorite pursuit. He is a gentleman of property and of education; and his untiring industry is manifested by the various works which he has either edited or published, and the various papers which he has

supplied for the transactions of different scientific bodies. But he is scarcely less celebrated among those who knew him, for his thorough knowledge of British ornithology, than for his liberality of feeling; and many of the museums of his neighborhood are indebted to him for valuable and rare donations. He resides at Twizel House, Northumberland; a situation well adapted from its neighborhood to the sea, for observing and procuring rare birds. He established, two years since, in conjunction with his brother-in-law, Sir William Jardine, Bart.—likewise a zealous naturalist,—the "*Magazine of Natural History*," a periodical work which has presented some valuable essays on the subject. He is also editor of the "*Library of Natural History.*"

In 1828, appeared the "*History of British Animals*," by John Fleming, D. D., minister of Flisk, Fifeshire, a synopsis, printed in one thick octavo volume, chiefly a compilation from previous writers.*

In 1835, Rev. Leonard Jenyns of Swaffhaur Bulbeck, near Cambridge, published a "*Manual of British Vertebrate animals, or descriptions of all the animals belonging to the classes Mammalia, Aves, Reptilia, Amphibia, and Pisces*," &c. He had previously published in a pamphlet form, a "*Systematic catalogue*," containing the ground work of this larger book.

The materials are nearly all original; on the subject of classification, no individual author has been rigidly adhered to; although he tends towards the opinion held by Mr. Mac Leay, of the circularity of natural groups. He was much assisted by Mr. Yarrell, as well as by Mr. Gray of the British museum, so that he had every facility for producing correctness, and performing the work in a good manner. Besides those species now found, he enumerates all the extinct species. "The object of the author is to present naturalists with a manual in this department of our Fauna, adapted to the existing state of our knowledge, and such as shall be calculated to meet the wants of science in that advanced age, to which it has attained since the publication of former works of this nature. In furtherance of the end, two

* I should desire to speak more particularly of this gentleman and his work, but am unable to find any particulars concerning him; and I have it not in my power to meet with a copy of the book at present. It is, in part, superseded by the later work of Jenyns.

points appeared necessary to be attended to. One was to ascertain, as far as practicable, the additions which had been made, of late years, to our list of British animals. * * * The other important point, was to take care that the descriptions should, as far as possible, be obtained from the animals themselves, and nothing inserted upon the credit of other writers, which was capable of being verified by personal observation. The day is forever gone by, in which unscientific compilations will be thought to be of any service to Zoology; so far from advancing its progress, it may be said unhesitatingly, that they tend only to retard it."

Hitherto, however much the birds themselves might have been attended to, their eggs and nidification, had been in a great measure neglected. Beautiful as are the former, and wonderful in their construction as are the nests; no one had as yet thought this branch worthy of separate attention. A French writer had, we believe, attempted a work, on this portion of the natural history of his own country; but had never completed it; and it was left to Mr. William Hewitson, to present the public, with the first original and well executed book, on this interesting topic. About 1831, he began to publish by subscription, in numbers, "*British Oology, being illustrations of the eggs of British birds,*" &c. It is in octavo, and consists of colored lithographic plates of the eggs, each one the natural size, and colored with great fidelity. A short description of the nest and eggs, accompanies each plate. To draw an egg, so that on paper it may appear natural, is no easy task, but being an excellent artist, he has accomplished his labors with great credit. The work now finished, is in three thin volumes, and contains *all* the British eggs, with the exception of a few of the very rarest.

Mr. Hewitson, who is still a young man, is descended from an old and highly respectable family in Newcastle upon Tyne. When a mere child he manifested a strong taste for drawing, and was fond of copying the figures and vignettes in Bewick's works. To these books, thus early put into his hands, he owes, we believe, his fondness for this science. He had the advantage of a liberal education, and became a civil engineer. As he grew up, his taste for drawing connected with natural history increased, and all his leisure hours he spent in the fields and woods. Like most boys he was fond of taking birds' nests; but unlike most boys, he became intimately acquainted with the species and varieties, and he

turned this knowledge to a good account. When he entered upon his profession, although his time was chiefly occupied with that, he yet found or made leisure not to neglect that which had afforded him so much satisfaction in his youth; and what time he could spare was spent in this absorbing pursuit. While engaged in publishing his work on Oology, he made a tour through Norway, for the purpose of procuring the eggs of such birds as are only migratory in Great Britain, and added several important facts to those with which we were already acquainted.

Although, as we have seen, Pennant had figured and described many of the British fishes, Mr. Donovan had given about one half of the species, and Mr. Jonathan Couch, of Cornwall, had established a high reputation as the Ichthyologist of that county; yet no one had hitherto treated this branch as one altogether national; and this is the more surprizing, when we consider that this country is entirely surrounded by the sea, that these animals form a very important part of food, and that the coast is comparatively very limited in extent, and unchangeable in climate.

For many years Mr. William Yarrell, of London, had been forming a collection of Fishes; and his possessing the advantage of being able to search the London markets, put him in possession of all such species as are more common, and many of the rarer ones. In 1836 appeared the first number of his '*History of British Fishes*,' which is completed in two thick octavo volumes. While this work is altogether popular, and the price moderate, as a scientific production it is invaluable; and it contains all that is known upon the subject, including a great variety of curious, and original information. It is printed in the same shape and style as Bewick's works, and each species is illustrated by a wood cut, executed in a manner perhaps unsurpassed in this art.

Mr. Yarrell is still alive, and is well known, equally for his urbanity of manners, his connection with science, his very valuable private collection in some branches of natural history, and his papers in the Linnæan and other Transactions. He is now engaged in publishing, in the same form as his volumes on fishes, a general work on British birds.

About the same time Dr. Bell, of London, published in like form a volume on the '*British Quadrupeds*' which includes all that are known, with a great variety of information concerning them.

The last writer upon British Testacea is Mr. Joshua Alder, of Newcastle upon Tyne, in the Transactions of the Natural History Society of Northumberland and Durham. He describes 71 species of land and fresh water shells as belonging to his neighborhood, many of which are new.

We have thus traced the gradual progress of natural science, as connected with Great Britain, from the days of Ray to our own times. We have seen how by degrees it has gathered strength, and how accuracy and scientific power also advanced. We have likewise seen that nearly all which has been accomplished has been done by those who had higher and more important duties to fulfil, but who, when weary, refreshed their minds by the observation of the works of God, instead of wasting in idleness or frivolous amusement, these their leisure hours. A complete account of the higher order of the zoology of that country, it is now in the power of any one to possess; and as regards the mammalia and birds, little probably remains to be added. But when we consider how each successive writer has thought that he had exhausted the stores of nature; how Ray supposed that the world did not contain above 150 species of beasts and reptiles, 50 of birds, and 500 of fishes, although now, in our own days, we have described 1200 species of mammalia, 6500 of birds, 8000 fishes, and 1500 reptiles, we may justly suppose and hope, that many more both of shells and fishes may be added to the list of the British Fauna. And as regards the United States we may learn how much is to be accomplished; although much has been done, and from what we do know, we may be incited to additional endeavors. Of this we may be assured, that as this study becomes more popular, so shall we see the mind of the people improving; simplicity of heart, and love of the works of God multiplied; and a thousand intellectual pleasures opened to those who, under Providence, are obliged to spend a larger part of their lives in harrassing and fatiguing employments. We shall find that this study forms a bond of union between the lower and the higher classes of society,—the practical mechanic and the man of science; that it increases human happiness, by enlarging the sphere of intellectual pleasure; for every new development of intelligence is a source of pure enjoyment. The bond of union will be the love of knowledge. There is an equality in science, for the great requisite is not the *amount* of information, but the *desire* to be informed.

# MISCELLANIES.

## DOMESTIC AND FOREIGN.

1. *Pictorial delineations by light; solar, lunar, stellar, and artificial, called Photogenic and the art Photography.*

*Remark.*—The great interest excited by this subject induces us to postpone the greater part of the miscellany which we had prepared and even set up for the present number, that we may make room for general notices from foreign Journals—detailing the history of the processes as far as known, and the most perfect state of the art, as far as it has gone.

### I. *Photogenic Drawings.**

Public attention has been called of late to a mode of drawing said to have been invented at Paris by M. Daguerre, and by which he fixes upon a metallic plate the lights and shadows of a landscape or figure solely by the action of the solar light. The interest thus excited has been increased by the publication of a series of experiments made by our countryman Mr. Talbot, directed towards the same object, and producing nearly similar results. In describing this interesting invention it will be well to commence with the first discoveries made by Mr. Wedgwood about the year 1800, and afterwards extended by Sir Humphry Davy.

The attention of these two eminent chemists was directed to the subject by the extraordinary effect produced by light upon the nitrate of silver, which led them to hope that the purposes of the artist might be assisted by the susceptibility of the metallic oxide. The first experiment was made by Mr. Wedgwood for the purpose of copying paintings upon glass, and was eminently successful; the copy obtained possessing all the figures of the original, in their native shades and colors; it was also in a high degree permanent, so long as it was preserved from the action of the light. The same gentleman discovered that the shadow of an opaque object thrown upon the paper was copied in outline with great correctness; but though both these celebrated chemists were constant and persevering in their endeavors to render the drawing permanent, they were entirely unsuccessful; the lighter shades darkening by exposures and thus obliterating the impression.

Their failure in this important object was published with their experiments in the Philosophical Transactions, and both having given up the attempt, their discoveries have since remained unimproved. But in the meanwhile M. Daguerre, it appears, struck by some hints he had received from a friend, has steadily pursued his experiments for the last twenty

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* Foreign Quarterly Review, No. 81.

years, and having at length attained his object has declared his discoveries and claimed the invention as his own. Full and satisfactory descriptions are promised by M. Arago and two other scientific engineers appointed to report on the subject, and in the interval a slight outline has been given in the French papers, from which the following account is taken.

A polished metallic plate is the substance made use of, and being placed within the apparatus is in a few minutes removed and finished by a slight mechanical operation. The sketch thus produced is in appearance something similar to aquatint, but greatly superior in delicacy; and such is the extraordinary precision of the detail that the most powerful microscope serves but to display the perfection of the copy. The first efforts of the inventor were directed towards architectural subjects, and a view of the Louvre and Notre Dame are among the most admired of these engravings. In foliage he is less successful; the constant motion in the leaves rendering his landscape confused and unmeaning; and the same objection necessarily applies to all moving objects, which can never be properly delineated without the aid of memory. But in the execution of any stationary subject, buildings, statues, flowers, the leaves of plants, or the bodies of animals, the fac-simile is perfect; and the value of the invention may therefore be easily conceived.

Several eminent artists have examined the designs, and were equally delighted with the precision and delicacy of the representation. Among the sketches exhibited by the projector was a marble bas-relief and plaster imitation; the first glance was sufficient to detect the difference between these two; and in three views of a monument taken in the morning, noon, and evening, the spectators easily distinguished the hours at which they were executed, by the difference of the light, though in the first and last instances, the sun was at an equal altitude.

But perhaps the anatomist or zoologist will derive the greatest advantages from the discovery, the form of the animal being as easily studied from the drawing as from the original, and the most powerful microscopes not having hitherto detected the smallest deficiency in the details. Nor is the invention devoid of interest to the astronomer, for the light of the moon is sufficient to produce the usual results, requiring only additional time for its operations. The following extract from "Le Commerce" is sufficient to substantiate its value in this respect:—"The experiments on the light of Sirius have confirmed the testimony of natural philosophy, and abundantly proved that the stars are bodies of the same nature as the sun; at the request of M. Biot, M. Daguerre has submitted his apparatus to the influence of the light of the moon, and has succeeded in fixing the image of that luminary. We observed that the image had a trail of light something like the tail of a comet, and we ascribe it to the movement of the body during the operation, which is of much longer duration than that by the light of the sun."

In the spring of 1834, Mr. Talbot began a series of experiments, with the hope of turning to useful account the singular susceptibility evinced by the nitrate of silver when exposed to the rays of a powerful light; but not being acquainted with the researches of former chemists on the subject, he commenced with the same disadvantages which had baffled the skill and perseverance of Sir Humphry Davy. The plan he at first proposed was, to receive a well-defined shadow upon a sheet of paper covered with a solution of nitrate of silver, by which means the part shaded would remain white, while the surrounding portion was blackened by exposure to the light. But he was well aware that the sketch thus obtained would require to be protected from the rays of the sun, and examined only by an artificial light. He had carried these inquiries to some extent, and become possessed of several curious results before he learned the steps which others had taken to attain the same object: and the decided terms in which Sir Humphry Davy expresses his failure might perhaps have discouraged his less experienced follower, had he not fortunately already conquered the difficulty which had destroyed the hopes of the former chemists.

Mr. Talbot continues:—"In the course of my experiments directed to that end, I have been astonished at the variety of effects which I have found produced by a very limited number of different processes when combined in various ways; and also at the length of time which sometimes elapses before the full effect of these manifests itself with certainty. For I have found that images formed in this manner, which have appeared in good preservation at the end of the twelve months from their formation, have nevertheless somewhat altered during the second year." He was induced from this circumstance to watch more closely the progress of this change, fearing that in process of time all his pictures might be found to deteriorate; this, however, was not the case, and several have withstood the action of the light for more than five years.

The images obtained by this process are themselves white, but the ground is differently and agreeably colored; and by slightly varying the proportions, and some trifling details of manipulation, any of the following colors were readily obtained:—light blue, yellow, pink, brown, black, and a dark green nearly approaching to black.

The first objects to which this process was applied were leaves and flowers, which it rendered with extraordinary fidelity, representing even the veins and minute hairs with which they were covered, and which were frequently imperceptible without the aid of a microscope. Mr. Talbot goes on to mention that the following considerations led him to conceive the possibility of discovering a preservative process. Nitrate of silver, which has become darkened by exposure to the light, is no longer the same chemical substance as before; therefore, if chemical re-agents be applied to a picture obtained in the manner already mentioned, the dark-

ened parts will be acted upon in a different manner from those which retain their original color, and after such action they will probably be no longer affected by the rays of the sun, or, at all events, will have no tendency to assimilate by such exposure; and if they remain dissimilar, the picture will continue distinct, and the great difficulty be overcome.

The first trials of the inventor to destroy the susceptibility of the metallic oxide were entirely abortive; but he has at length succeeded to an extent equal to his most sanguine expectations. The paper employed by Mr. Talbot is superfine writing paper; this is dipped into a weak solution of common salt, and dried with a towel till the salt is evenly distributed over the surface: a solution of nitrate of silver, is then laid over one side of the paper, and the whole is dried by the heat of the fire. It is however, necessary to ascertain by experiment the exact degree of strength requisite in both the ingredients, for if the salt predominates, the sensibility of the paper gradually diminishes, in proportion to this excess, till the effect almost entirely disappears.

In endeavoring to remedy this evil, Mr. Talbot discovered that a renewed application of the nitrate not only obviated the difficulty, but rendered the preparation more sensitive than ever: and by a repetition of the same process the mutability of the paper will increase to such a degree, as to darken of itself without exposure to the light. This shows that the attempt has been carried too far, and the object of the experimentalist must be to approach, without attaining this condition. Having prepared the paper and taken the sketch, the next object is to render it permanent, by destroying the susceptibility of the ingredients for this purpose. Mr. Talbot tried ammonia and several other re-agents with little success, till the iodide of potassium, greatly diluted, gave the desired result; this liquid, when applied to the drawing, produced an iodide of silver, a substance insensible to the action of light. This is the only method of preserving the picture in its original tints, but it requires considerable nicety, and an easier mode is sufficient for ordinary purposes. It consists in immersing the picture in a strong solution of salt, wiping off the superfluous moisture, and drying it by the heat of the fire; on exposure to the sun, the white parts become of a pale lilac, which is permanent and immoveable. Numerous experiments have shown the inventor that the depth of these tints depends on the strength of the solution of salt; he also mentions that those prepared by iodide become a bright yellow under the influence of heat, and regain their original color on cooling. Without the application of one of these preservatives the image will disappear by the action of the sun; but if inclosed in a portfolio, will be in no danger of alteration: this, Mr. Talbot remarks, will render it extremely convenient to the traveller, who may take a copy of any object he desires, and apply the preservative at his leisure. In this respect Mr. Talbot's system is greatly superior to that of M. Daguerre, since it would be scarcely pos-

sible for a traveller to burden himself with a number of metallic plates, which in the latter process are indispensable.

An advantage of equal importance exists in the rapidity with which Mr. Talbot's pictures are executed; for which half a second is considered sufficient; a circumstance that gives him a better chance of success in delineating animals or foliage; and although our countryman has not thought it necessary to adorn his invention with his own name, nor to keep it a secret till he could sell it to advantage, his claim to originality is equal to M. Daguerre's, and can only be rivalled by that of Mr. Wedgewood, the real discoverer and originator of the art.

Since the publication of the above discoveries, numerous candidates have appeared in the field, all claiming the palm of originality, while philosophers of every grade and county have eagerly pursued the investigation of the subject. The first we shall notice is M. Niepce, who claims priority even over M. Daguerre; and the account he publishes, if correct, will undoubtedly determine the question in his favor. A letter from M. Bauer is the principal evidence for M. Niepce, who it appears mentioned his discovery to this gentleman in the year 1827, while on a visit at Kew, and by the advice of his friend he drew up a memoir on the subject, and caused it to be forwarded to the Royal Society. This document was, however, returned, it being contrary to the rules of the Association to receive accounts of scientific discoveries unless they detailed the process employed. M. Neipce shortly afterwards returned to France, having presented to his friend several specimens of the newly discovered art, which are still in the possession of M. Bauer. The pictures taken, are of two kinds, copies from engravings, and copies from nature; the best of the former is in the possession of M. Cussel, and is considered nearly equal to those of M. Daguerre, with suitable allowance for twelve years' exposure; the specimen taken from nature, is however, by no means so successful, and is considered inferior to the earliest attempts of his countryman. There can be little doubt that the principle of both processes is precisely the same, though greatly improved by diligent experiments, the material employed in each being a metallic plate, apparently covered with transparent varnish; but whether intended to receive or to fix the impression is not at present made public. We now come to a statement of M. Bauer, which, if not founded on error, will raise the invention of Niepce far above those of both his rivals; he distinctly asserts that he possessed copies of engravings produced solely by the action of light, which were capable of being multiplied in the same manner as an ordinary copperplate; if this be the case, the greatest secret still remains unknown, even to M. Daguerre himself. It is much to be regretted that M. Niepce did not at once publish his extraordinary discovery, with a full detail of the process employed, as he would then have retained the indisputable right to the merit of the invention, but having preserved the secret so long, and

the process being in every respect so different, we cannot see that it in any way interferes with the position of Mr. Talbot.

We must leave this question and now proceed to analyze the claims of two of our countrymen, Messrs. Havell and Wellmore, who are said to have introduced an important addition to the process pursued by Mr. Talbot, a full description of which is contained in a letter to the editor of the Literary Gazette. The first attempt of this gentleman was directed towards an etching, by Rembrandt, of an old man reading, and the result was a reversed fac-simile; a negro face surmounted by locks of silver; the disappointed artist discovered that a second transfer entirely destroyed the spirit of the picture. To remedy this evil he had recourse to a new process, by which this defect was indeed removed, but the great merit of the art, namely, self-acting power, was lost. A thin plate of glass was laid on the subject to be copied, upon which the high lights were painted with a mixture of white lead and copal varnish, the proportion of varnish being increased for the darker shading of the picture. The next day Mr. Havell removed the white ground with the point of a penknife, to represent the dark etched lines of the original, and a sheet of prepared paper having been placed behind the glass and thus exposed to the light, a tolerable impression was produced; the half tints had, however, absorbed too much of the violet ray, an imperfection which was remedied by painting the parts over with black on the other side of the glass; if allowed to remain too long exposed to the sun's rays the middle tints became too dark, and destroyed the effect of the sketch; about ten minutes in a powerful sun was considered sufficient. Another method employed by Mr. Havell was to spread a ground composed of white lead, sugar of lead, and copal varnish, over a plate of glass, and having transferred a pencil drawing in the usual manner, to work it out with the etching point till it bore the appearance of a spirited ink drawing, or in the hands of an engraver a highly finished engraving. The above process Mr. Havell made public under the impression that it had been hitherto overlooked, but Mr. Talbot, hearing that he was about to apply for a patent, laid claim to the improvement as his own, and not only pointed out some parts of his former memorial where it was distinctly mentioned, but also produced several drawings made precisely in the manner described; he has also laid before the Royal Society a new method of preparing the sensitive paper, which consists in immersing it in a solution of nitrate of silver, and after washing it with bromide of potassium, the nitrate of silver is again applied, the preparation being dried by the fire between each operation; the paper thus treated is extremely sensitive, changing with the feeblest daylight, first to a bluish green then to olive green, and finally to black.

A letter to Mr. Talbot from his friend M. Biot has also been published, and contains many interesting experiments. After commenting on the value of the discovery, he continues—"The interest with which I viewed

this circumstance, engaged me to make some experiments upon your preparation, in order to vary its application to the researches in which I am occupied. First, I wished to know whether the change of color was in any degree influenced by the paper itself; I therefore spread the substance on a piece of white unglazed porcelain instead of paper, taking care to operate by night, and drying it each time at the fire, as you say, I thus obtained a dry solid coating upon the porcelain, which I shut up in a dark place until the morning. In the morning I took it out, and found it of a pale sulphur yellow color: I then presented it to the daylight at an open window looking north; the weather was then very cloudy; yet no sooner had I so presented it than already it was turned green, and soon afterwards it became black. I then wished to know whether the preparation would succeed equally well if not dried at the fire; I therefore, in a darkened room, mixed the aqueous solution of bromide of potassium with that of nitrate of silver; a precipitate fell, which I spread on a porcelain plate and left it to dry in the dark; the next day I wrapped it in several folds of paper, and brought it into another room to show it to a friend; but having taken off the covers in a dark corner of the room in order to exhibit the original color, pale lemon yellow, instantly we saw its tint become green, and I had hardly time to present it to a window opening to the north before its color had passed to dark olive green, after which it almost immediately became nearly black. I do not think it possible to find any substance more sensitive to light." Had M. Daguerre or M. Niepce published their experiments at the commencement, Mr. Talbot would have appeared merely as an improver of a foreign discovery.

We must notice here that, by possibility, this art may not be altogether unknown to jugglers in India. It is many years since an offer was made, in our presence, by one of them, to show any gentleman his portrait taken by a single look alone. The master of the house, however, deeming the proposal an insult on the credulity of the company, ordered the man of science to be instantly expelled with the rattan.

## II. *Photographic processes, by Andrew Fyfe,* M. D., F. R. S. E., &c.*

Photography may be divided into three parts: the preparation of the paper,—taking the impressions,—and preserving them.

### 1. *Methods of preparing the Paper.*

Though paper besmeared with solution of lunar caustic is darkened by exposure to light, it is by no means *sensitive;* other methods have therefore been recommended for preparing it for photographic purposes. That originally given by Mr. Talbot is to soak it first in a weak

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* Read before Soc. of Arts Edinb. Mar. and Apr. 1839. From the New Edinb. Phil. Jour. April to July, 1839.

solution of sea-salt, and when dry, to rub it over on one side with solution of lunar caustic, by which *chloride of silver* is formed, and adheres to the paper. As thus prepared, it acquires a dark color on exposure to light; the depth of color depending on the strength of the solutions; hence it may vary from lilac to deep purple, approaching to black.

In preparing paper by this method, it is very difficult to get the chloride uniformly spread over the surface, and accordingly, when exposed to light, it often gives a variety of shades; indeed, in many places it continues white. It was this that induced me to try the use of other salts of silver; and the one which I have found to answer best is the *phosphate*, procured in the usual way, by the addition of the phosphate of soda to the solution of lunar caustic. In preparing the paper by this method, I generally employ one part of phosphate of soda dissolved in about eight of water, and the nitrate of silver dissolved in about six of water. The paper is first soaked in the phosphate, and then dried, after which the nitrate is put on on one side by a brush, the paper again dried and afterwards again put through the salt, by which any excess of silver is converted to phosphate. As thus prepared, it acquires a yellow tinge, which becomes black by exposure to light. It is equally *sensitive* as the chloride, and, in my opinion, gives a much more pleasing variety of shades.

Instead of preparing the paper by the process described, I frequently employ the phosphate precipitated before applying it, for which purpose the nitrate solution is dropped into that of the phosphate of soda, the yellow precipitate is allowed to fall to the bottom, and the supernatant fluid is poured off; what remains must be kept in stone bottles or in a dark place, as it is extremely sensitive to light. In preparing the paper with it, it is put on with a broad flat brush, and then dried in the usual way. Though there is a little difficulty at first in getting the phosphate uniformly spread over the surface, yet by a little practice a uniform ground is easily given, and when once acquired, the method has the advantage of being much cheaper than those previously recommended. I sometimes add a little mucilage to the fluid, which keeps the phosphate suspended in it. There are other methods of preparing the paper, which though they do not give it so sensitive, yet are cheaper than those stated; I allude to the use of the phosphate in solution in ammonia, or, which is cheaper, in the carbonate of ammonia which is procured by adding concentrated solution of carbonate of ammonia to the phosphate collected by precipitation as already described. A still cheaper fluid may be prepared by adding a strong solution of nitrate of silver to a concentrated solution of carbonate of ammonia, by which a *carbonate of silver* is obtained in solution, and

which can be applied to the paper on one side by means of a brush. Paper thus prepared is white; it has the advantage of being easily prepared, and of giving, on exposure to light, a uniform ground which is of a brownish color.*

### 2. *Methods of taking the Impressions.*

From what has been already stated, it must be evident that the most direct mode of taking the impressions is, by placing on the paper the object, the delineation of which is wished, and then exposing it to the light. For this purpose it ought to be kept as close as possible on the paper, and the best method of doing so is to place it in a frame with glass in front, and a stuffed cushion behind it. The time required depends, of course, on the intensity of the light, and the density of the object; and it is of the utmost consequence to take care that it is long enough exposed, and that, at the same time, the exposure is not too long continued, for if not long enough, though the outline will be given, yet the representation will not be distinct in all its parts; whereas if too long continued, the fainter parts begin to darken, and the representation is indistinct. The time required must be found by practice. In bright sunshine one minute will be sufficient for some objects: when there is no sunshine an hour or two may be required, and in this case there is little or no danger of destroying the impression by too long exposure, as the light is not of sufficient intensity to darken too much the fainter parts.

*Impressions from Engravings* may likewise be got in the same way; and for this purpose, instead of using those thrown off on thin paper, by which it is supposed the light is most easily transmitted, it is, I think, better to take those on thick paper, because, though the light is not so easily transmitted, yet the impression of the engraving is much bolder, so that a more distinct delineation is given by the photographic process.

*Camera Obscura.*—The use of the camera obscura for photographic purposes, has been described by Mr. Talbot. Though representations may be got in this way, yet, so far as I have found, they have not the minute distinctness of those got by the method already noticed. Owing to the interference of the lens, the light does not act nearly so powerfully on the paper, as when it has to permeate merely a frame of glass. The same is the case when the light is reflected,

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* Instead of purchasing lunar caustic of commerce, a cheaper method of procuring it is to dissolve pure silver in nitric acid diluted with its own bulk of water, taking care to have in the vessel more silver than the acid can dissolve; and after it has taken up as much as it can, to dilute the solution with four or five parts of water, or thereabouts, according to the color required.

and hence the necessity of getting quit of the mirror placed in cameras, for throwing the representation in such a way as to allow of its being traced by the artist. Hence, in taking impressions by the camera, the prepared paper must be fixed *on the back of the box*, directly opposed to the lens, and the focus properly adjusted. I have found great advantage, in taking impressions by the camera, in using the paper moist, and keeping it so all the time it is exposed. For this purpose, after moistening it, I place it between a cushion and a pane of glass, tied tightly together, to prevent, as much as possible, the escape of moisture. In this way I have succeeded in a few minutes in getting a faint outline of the object exposed to the lens.

I may here mention that the camera affords a good method of taking profiles from busts, not by the reflected light from the bust, but by interposing it between the lens and the source of light. The bust, for instance, may be placed, during sunshine, at an open window, and the image from it thrown on the prepared paper; using the precaution, of having the face slightly inclined towards the source of light, so as to give its outline as distinctly as possible.

*Etchings.*—A method of taking impressions of etchings on glass by the photographic process was described by Havell of London. For this purpose the glass is covered with etching varnish, and after the figure is etched on it, it is smoked, so as to darken the varnish to prevent the transmission of light; of course, the smoke does not adhere to those parts of the glass exposed by the etching needle, and is therefore easily wiped off with a cloth, thus leaving the etching free for the light to pass through. On exposing this with the prepared paper behind it, a beautiful impression is taken. In taking impressions in this way, the *varnished side* must be placed *next the paper*, which must be kept close upon the etching by means of a cushion, otherwise the impression is not well defined. When the glass side is next the paper, the impression is very indistinct, owing to the light, when it passes through the exposed parts of the glass, being diffused, and by which the lines run into each other.

From the ease with which impressions can be got in this way, it occurred to me that the process might be still farther extended, so as to enable us to take copies of oil paintings, or of drawings on boards, through which the light does not penetrate, and for this purpose I have followed different methods. One of these is to cover the glass with a transparent varnish, as with a thin solution of Canada balsam in oil of turpentine, and, after laying it down on the oil painting, to etch it out on the varnish, in the usual way; after this, the glass is to be slightly heated, so as to soften the varnish, which is then to be smoked, by holding it in the flame of an argand gas lamp, taking care

not to soften the varnish too much; when cold, the smoke is wiped off with a cloth from the parts of the glass exposed by the etching needle. Another method is to cover one side of the glass with starch solution, of such strength, that when dry it is transparent, and it is then to be laid down with the glass side next the paintings, which can be traced with a pencil on the starch, and then etched on the other side, as already described. From glass etchings thus procured, impressions are taken in the usual way.

This process of transparent etching is applicable to the camera obscura; for, instead of using ground glass, as is commonly done, the representation may be thrown on starched glass, on which it is traced and then etched on the other side, as above described.

Before finishing this part of the subject, I may here allude to a method of taking the impressions, by which I have succeeded in giving them a resemblance to oil paintings.

By the method noticed, paper, or some absorbing substance, is used. I have already stated that the phosphate suspended in water may be employed, which suggested to me the use of the same substance along with a varnish, in the hopes of being able to take the impression on panel-board or metal. I have found this to answer as well as with paper. The varnish I have used is Canada balsam and turpentine, with which the phosphate, dried by the cautious application of heat, and excluded from light, is thoroughly incorporated; with this the panel-board, previously prepared as for an oil painting, is varnished; when dry, the impression is taken on it in the usual way. It will be found to have all the richness of an oil painting.

By this process, impressions equally distinct and brilliant may be taken on metal. Perhaps this may be of service in saving engravers the time and trouble of laying down on the metal the figure to be engraved.

The impressions received by the modes now described are taken by exposure to the solar ray. It is well known that the paper may be darkened by other means, as by the oxyhydrogen blowpipe; but there is no necessity for having recourse to so intense an artificial light. I have found that, by concentrating the light of a common fire by metallic mirrors, the paper is darkened, and the same also occurs with the flame of a gas lamp. Of course, the time required is much longer than when exposed to sunshine. In this way I have succeeded in getting impressions of dried leaves almost as distinct as by solar light; indeed we may dispense altogether with the mirror, for, by exposing the paper with the leaf on it, in a frame, to the light of a common fish-tail gas-burner, at the distance of a few inches, I have procured specimens, some of which, though on a small scale, have all the richness of those taken by solar light.

The concentration of the rays by a metallic mirror, so as to get quit of the interference of the lens, would no doubt be a great improvement in the camera obscura, provided it could be accomplished. May not something of this kind be the method followed by Daguerre in getting his camera representations?

### 3. *Preservation of the Impressions.*

It is evident that, as the impression is produced by the agency of light on the compound of silver, when the paper is again exposed, the light will begin to act, and ultimately darken the whole, thus effacing the impression; hence the necessity of a preservative process. Two methods have been recommended by Mr. Talbot, as applicable to the *chloride*, one by the iodide of potassium, the other by sea-salt. When solution of iodide of potassium is added to that of lunar caustic, a yellow iodide of silver is thrown down. The same is the case when the iodide is put on paper, previously covered with the chloride, and, provided the solution is strong, it acts also on the chloride when darkened, thus converting it to yellow iodide, which is not in the least affected by light; hence, by putting the paper with the impression through solution of the iodide, provided it is weak, the white chloride only is acted on, and being converted to iodide, is no longer liable to change. As, however, the iodide will act on the dark chloride, it is of the utmost consequence to attend to the strength of the solution, which should be such that it will not attack the faint parts of the impression. After the paper is passed through it, it should be kept for some time in water, to wash off the superfluous iodide of potassium, which, if left on, would gradually destroy the whole of the impression; indeed, even with this precaution, I find it extremely difficult to preserve them. The second method recommended by Mr. Talbot is merely immersing the paper in solution of sea-salt. This process does not, however, seem to answer well; I have repeatedly failed in preserving the specimens in this way, and even when they are preserved, they are completely altered in their appearance, and deprived of their original brilliancy.

I have already stated, that I prefer the phosphate of silver for taking the impressions, not only because it is equally sensitive as the chloride, but gives a greater variety of shades. In addition to these, it has another advantage; the impressions are easily preserved. After various fruitless attempts, I at last found that the darkened phosphate is not soluble in ammonia, though, as is well known, the yellow phosphate is easily dissolved. I had, therefore, recourse to this for their preservation, and though I did not completely succeed at first, yet I at last did so, by attending to the precaution of washing off he ammoniacal solution, because, when left on, the impression gradu-

ally becomes darker and darker, and is ultimately destroyed, owing to the action of the light on it. The method I now follow is to put the paper into a diluted solution of water of ammonia (one of the spirit of hartshorn to about six of water,) and leave it there till the yellow parts become white, showing that the phosphate is dissolved, after which it is washed with water to carry off the whole of the ammoniacal solution. It should then, when nearly dry, be subjected to pressure till dried, by which it is prevented from wrinkling, and the impression retains its original sharpness, which, unless this is done, it is apt to lose, by the fibre of the paper being raised by the repeated moistening.

Though the phosphate specimens may be preserved in this way, yet they do not retain exactly their original appearance. Those parts whitened by the ammonia, owing to part of the silver being united with the paper, gradually acquire a faint reddish tinge,—but, though altering the appearance, it does not affect the brilliancy; indeed, in some cases it rather improves it, by giving a pleasing tint, which contrasts well with the darker parts, and gives the appearance of coloring. I have also found that carbonate of ammonia answers equally well, and, being much cheaper, it will of course be preferred. I generally employ a solution, prepared by dissolving one part of salt in about four of water, in which the paper is kept for a minute or so, and then afterwards washed, and subjected to pressure, as already noticed. Impressions thus preserved acquire the same reddish tinge as those acted on by ammonia.

I have before stated that the paper may be prepared by washing it over with a solution, procured by adding nitrate of silver to carbonate of ammonia. The impressions taken with that paper are easily preserved by merely washing them with water, to carry off the part not acted on by the light, which is another advantage, in addition to those stated, for using the carbonate solution. Like the phosphate specimens, they also acquire a reddish tint.

Other preservative methods have been recommended, as, by covering the impressions with a yellow color, to prevent, as much as possible, the transmission of the chemical ray of the light; but those above stated, particularly when the phosphate or carbonate is used, are so simple and efficacious that it is unnecessary to allude to them.

Before finishing this part of the subject, I may here allude to a valuable practical application of photography, in diminishing the labors of the lithographer. In communicating the impression of any object to the stone, as of a dried plant, or in copying an engraving, it is necessary to trace them on paper, and after again tracing them with the transfer ink, transfer them to the stone. Now, by receiving the impression on paper by the photographic process, all the labor of the

first tracing is avoided. But there is no necessity for using paper, as the impression may at once be communicated to the stone, which easily receives the phosphate, and which may therefore be prepared in the same way as the papers, and the impression also taken in the usual manner, after which it is traced over with the transfer ink. By this process not only is a great deal of labor saved, but the representation must be much more exact than when traced; for though by the latter the outline is correct, yet much is left to be afterwards filled in by the eye, whereas, by the photographic process, every, even the most minute filament, is distinctly and accurately laid down on the stone.*

### *Method of taking Impressions in which the lights and shades are not reversed.*

By the different methods now described for getting photographic impressions, the lights and shades are always reversed, because, as it is by the action of the light that the compound of silver is darkened, wherever it is prevented from penetrating, the paper retains its original color. Though the impressions thus procured are accurate as to outlines, yet in many cases the representation is far from being pleasing; it is therefore a great desideratum to have a method of getting impressions in which there is no reverse; in fact, to give a true representation of the object, and in this I have succeeded by the use of the iodide of potassium. I have already stated, that when the darkened phosphate is exposed to the iodide, it is instantly converted to yellow, provided the solution is of sufficient strength; if weak, the action goes on slowly. In some impressions which I had attempted to preserve in this way, I observed that when exposed to light they began to fade, which induced me to try the effect of light on darkened paper, soaked in solution of iodide, of such strength that it just failed to attack it instantly. In my first attempt I succeeded in bleaching the paper, but in my next I failed. On considering the circumstances under which these trials were made, I found that the only difference between them was, that in the first the paper was moist, in the last it was dry. Accordingly, on repeating the experiment with the paper moist, I again succeeded in getting a delineation of the object placed on the paper, as distinct and altogether as brilliant as those obtained by the other process.

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* For this method of applying the photographic process I am indebted to Mr. Nichol, lithographer, by whom lithographic impressions, thus taken, were exhibited to the Society of Arts. As a proof of the value of this process, I may also mention, that on the evening of the 17th of April, when I exhibited a photographic specimen of dried ferns, it was, by Mr. Forrester, lithographed, and impressions taken from it, in the course of two hours; had this been done in the usual way, it would have required many hours of labor, and after all not have given such accurate delineations.

The method which I now follow is, after preparing the phosphate paper, to darken it, then immerse it in solution of iodide of potassium, of such strength that it does not act instantaneously, and, *when still moist*, to expose it to light with the object on it, and continue the exposure till the exposed part of the paper becomes yellow. In this case, there is a tendency in the iodide to convert the dark phosphate to yellow iodide, which go on slowly, but is hastened by the light; of course, if the object on the paper is impervious to light, the impression is black throughout, but if it is of different density, so as to allow the light to be differently transmitted, the impression presents the lights and shades as in the object itself; because those places behind the dense pieces retain their original blackness, while those behind the less dense are more or less bleached, just according to the transmission of the light. When impressions thus procured are kept, they begin to fade, owing to the slow but continued action of the iodide of potassium; hence the necessity of a preservative process. After repeated trials, I have found, that by far the simplest and the best is merely immersion in water, so as to carry off the whole of the iodide of potassium notacted on by the phosphate, and by which any farther action is completely prevented. By this method, the specimens do not lose in the least their original beauty, and they may be exposed to continued sunshine without undergoing the slightest alteration.

I have succeeded also in taking impressions with the chloride in the same way—but it is necessary for the success of the process, to use the solution of the iodide much weaker than for the phosphate, because the chloride is more easily acted on. In both cases it ought to be made of such strength that it just acts, and then, before using it, it must be weakened by the addition of a little water. For the phosphate, it will be found, in general, that 1 of salt to 10 of water, and for the chloride, that about 30 of water, will give a solution of the requisite strength. Of course, in preserving the specimens, the precautions as to washing and pressure must be attended to.

## III. *Perfection of the Art, as stated in Notes on Daguerre's Photography.* By Sir John Robison.*

Sir—In compliance with the request, that I should commit to writing and put into your hands the substance of what I communicated to the Society of Arts in reply to the questions put to me at the last meeting, I beg to state, that circumstances having led to my being included in a small party of English gentlemen who were lately in-

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* Secretary to Royal Society of Edinburgh, &c. &c. (Communicated by the Society of Arts.) **Edinb. Jour.**

vited to visit the studio of M. Daguerre, to see the results of his discovery, I had an opportunity of satisfying myself, that the pictures produced by his process have no resemblance to any thing which, as far as I know, has yet been produced in this country; and that, excepting in the absence of color, they are as perfect images of the objects they represent, as are those which are seen by reflection from a highly polished surface. The perfection and fidelity of the pictures are such, that on examining them by microscopic power, details are discovered which are not perceivable to the naked eye in the original objects, but which, when searched for there by the aid of optical instruments, are found in perfect accordance: a crack in plaster, a withered leaf lying on a projecting cornice, or an accumulation of dust in a hollow moulding of a distant building, when they exist in the original, are faithfully copied in these wonderful pictures.

The subjects of most of the numerous specimens which I saw, were views of streets, boulevards, and buildings, with a considerable number of what may be termed interiors with still life; among the latter were various groups made up of plaster-casts and other works of art. It is difficult to express intelligibly a reason for the charm which is felt in beholding these pictures; but I think it must arise, in some measure, from finding that so much of the effect which we attribute to color, is preserved in the picture, although it consist only in light and shade; these, however, are given with such accuracy, that, in consequence of different materials reflecting light differently, it is easy to recognize those of which the different objects in the groups are formed. A work in white marble is at once distinguished from one in plaster-of-Paris by the translucency of the edges of the one, and the opacity of the other. Among the views of buildings, the following were remarkable: A set of three pictures of the same group of houses, one taken soon after sunrise, one at noon, and one in the evening; in these the change of aspect produced by the variations in the distribution of light, was exemplified in a way which art could never attain to.

One specimen was remarkable from its showing the progress made by light in producing the picture. A plate having been exposed during 30 seconds to the action of the light and then removed, the appearance of the view was that of the earliest dawn of day; there was a grey sky, and a few corners of buildings and other objects beginning to be visible through the deep black in which all the rest of the picture was involved.

The absence of figures from the streets, and the perfect way in which the stones of the causeway and the foot-pavements are rendered, is, at first sight, rather puzzling, though a little reflection satisfies one that passing objects do not remain long enough to make any

perceptible impression, and that (interfering only for a moment with the light reflected from the road,) they do not prevent a nearly accurate picture of it being produced.

Vacillating objects make indistinct pictures, *e. g.* a person getting his boot cleaned by a decrotteur gave a good picture, except that having moved his head in speaking to the shoe-black, his hat was out of shape, and the decrotteur's right arm and brush were represented by a half-tinted blot, through which the foot of the gentleman was partially visible.

There can be no doubt that when M. Daguerre's process is known to the public, it will be immediately applied to numberless useful purposes, as by means of it, accurate views of architecture, machinery, &c., may be taken, which being transferred to copper or to stone, may be disseminated at a cheap rate; and useful books on many subjects may be got up with copious illustrations, which are now too costly to be attainable: even the fine arts will gain, for the eyes accustomed to the accuracy of Daguerrotype pictures, will no longer be satisfied with bad drawing, however splendidly it may be colored. In one department, it will give valuable facility. Anatomical and surgical drawings, so difficult to make with the fidelity which it is desirable they should possess, will then be easily produced by a little skill and practice in the disposition of the subjects and of the lights.

It is a curious circumstance that, at the same time that M. Daguerre has made this beautiful and useful discovery in the art of delineation, another Parisian artist* has discovered a process by which he makes solid casts in plaster of small animals or other objects, without seams or repairs, and without destroying the model, (Moulage d'une seule pièce, sans couture ni reparage, et avec conservation parfaite du modele). I am in possession of several specimens of his work, among which are casts of the hand of an infant of six months, so delicately executed, that the skin shows evident marks of being affected by some slight eruptive disease. I am, dear Sir, very faithfully yours,

JOHN ROBISON.

JAMES TOD, Esq., Secretary to the Society of Arts.
Edinburgh, 1st June, 1839.

2. *Correction of an error—Cinnabar not found in Michigan.*—In Vol. I, at page 33, of this Journal, it is stated in a letter to Dr. J. L. Comstock by B. F. Stickney, that "a black and garnet colored sand is found on the shores of Lake Erie and Michigan which is a sulphuret of mercury and yields about 60 per cent. of that metal." No confirmation of this too

* Hippolyte Vincent, Mouleur, Rue Neuve St. François No. 14 (au Marai).

hastily accredited report having been given, we have long supposed that it was a mistake, and that credence had been too easily given by us to a result which if true, would have been extremely important, and which we confess we ought not to have admitted without the most rigorous proof. It is now in our power to settle this matter on the authority of Mr. Stickney himself, and through the kindness of our friend Josiah Thompson of Philadelphia, from whom we have received a letter dated June 29, ult., and covering a letter to him from Mr. Stickney dated Dec. 21, 1831, thirteen years after the first publication of the supposed discovery of cinnabar. Mr. Thompson remarks: "When in the west some years ago I visited the localities mentioned, (on the shores of lakes St. Clair and Erie,) and soon found that the sand in question contained no mercury, but was probably composed of garnets either broken up or in very small crystals. I afterwards wrote on the subject to Mr. Stickney who gave me the substance of his subsequent researches in the annexed communication."

"I should not have thought of reviving the thing at so late a period had I not heard it alluded to by a very distinguished scientific lecturer, whose authority for the assertions had been derived from the communications originally appearing in your widely circulated Journal, and which have been transferred to several standard works both American and European."

We now quote Mr. Stickney's statement:

"Some nine or ten years since I lay wind bound on the western shore of Lake Erie, with a small craft for several days, near the mouth of Otter Creek, a little south of Pleasant Bay, where the black and garnet colored sand is abundant. It struck me as probable, that it was a sulphuret of mercury. I levigated a few grains of the latter between two stones; the bright, opaque, red appearance when broken tended to confirm me in the opinion. Having no other employment, I mixed clay, water, and sand, with my hands and formed it into a retort and receiver; dried them in the sun; and afterwards baked them in the hot sand and ashes when we had a fire on the beach. I then introduced a small portion of the red sand into the retort; it could be but a small portion, as it did not hold more than half a pint. I set up my apparatus with small stones; fitting on and luting the receiver with some of the same clay and sand. Thus prepared, I put charcoal from our fire into the little furnace, and blowed them with a blowpipe made of a hollow weed. After continuing it for a time at a low red heat and permitting it to cool moderately, I broke the receiver, and discovered, as I then conceived, minute globules of mercury. I now concluded I had determined the presence of mercury in the sand. I took with me quantities of the sand; and when I returned home I submitted some of the red sand pulverised to nitro-muriatic acid, and precipitating the solution with carbonate of potash, I had a copious white precipitate. I weighed the sand; but having accidentally spilled some of the solution, I did not weigh the result. I made minutes at the time which

I now refer to. About eighteen months since, making some experiments on iron ore, I obtained a white precipitate,* so near resembling that from the sand, that I was led to suspect my mistake. I now undertook another and more minute examination of the sand. I obtained the same white precipitate, and submitted it to sublimation, but found no mercury, but every appearance of iron. I have examined the sand with the magnet and glasses. The black I think is a rich iron ore, highly magnetic; the red and reddish we may consider, and perhaps with safety, garnet and carnelian. In some places about the shores of these lakes there are large quantities of the black and red sand; some nearly all black, and others mostly red. I have specimens from Lake Michigan that are all black and all magnetic. When we commit an error, it is more important that it should be corrected than to develope a new truth. I therefore have a desire that this correction should be as extensively known as the error."

3. "*An Essay on the Development and Modifications of the External Organs of Plants. Compiled chiefly from the writings of* J. Wolfgang Von Goethe, *for a public lecture to the class of the Chester County Cabinet of Natural Science.* By William Darlington, M. D." West Chester, Penn. 1839. 12mo. pp. 38.—The object of this essay, is, in the words of its author, to give "an exposition of the views which are entertained by some of the most eminent naturalists of the age, respecting the successive development and modification, or transformation, of the external organs of Plants; showing that all their appendages,—from the crude cotelydons of the germinating seed, to the most delicate component parts of the perfect flower,—are nothing but modified forms of that expansive tissue which envelopes the tender shoots of plants, and is the principal seat of vegetable life; or, in other words, that the organized covering, called the *bark* of plants, is the original *raw material*, (if I may so term it,) from which are formed and elaborated all those multiform organs, or appendages to the stem and branches, known by the names of Leaves, Stipules, Bracts, Involucres, Glumes, Calyces, Corollas, Nectaries, Stamens and Pistils." The germ of this doctrine is found in the writings of Linnæus, but it was first fully developed in 1790, by Goethe, whose fame as a poet has eclipsed his reputation as a naturalist. The labors of succeeding botanists have established its truth. Dr. Darlington has presented this curious subject in an interesting and lucid manner, and with his accustomed scientific accuracy.

4. *Journal of the Essex County (Mass.) Natural History Society*, 8vo., Salem.—The first number of this Journal was published in 1836,

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* An equivocal inconclusive result.—*Eds.*

and comprises 44 pages. Its contents are: Anniversary Address, by John L. Russell, M.D.; the Act of Incorporation, Constitution and Bye-Laws of the Society; Catalogues of its Officers and Books, and of the Donors to the Library and Cabinet.

The second number was published a few weeks since, and extends from page 45 to page 108. It comprises the following papers:

1. Familiar notice of some of the shells found in the limits of Essex County, Mass., with reference to descriptions and figures; by John L. Russell, page 47 to page 76.

2. Notice of the occurrence of specimens of Vespertilio pruinosus, Say, (Hoary Bat;) by H. Wheatland. 76, 77.

3. A sketch of the Geology and Mineralogy of the southern part of Essex County in Mass. communicated to the Essex Co. Nat. Hist. Soc. April 24, 1839; by Wm. Prescott. 78—91.

4. Two new species of Musci, with figures; by John L. Russell. 92, 93.

5. Remarks on Hyla femoralis, observed in the north parish of Danvers, Mass.; by Andrew Nichols. 93—96.

6. Notice of rare plants; with a description of a curious variety of Cladonia Uncialis; by John L. Russell. 96—100.

7. Remarks upon Scarabæus Goliatus and other African beetles allied to it; by Thaddeus Wm. Harris. 101—107.

The Society was incorporated in February, 1836, by the Legislature of Massachusetts. From the prefatory remarks in the second number it appears that the institution is in a prosperous condition, and has already collected a considerable cabinet and library. Of the industry and ability of the members, we have good evidence in the numbers before us. We gladly welcome every new laborer in American Natural History; for notwithstanding what has been already accomplished, the field of discovery is yet very far from being exhausted, and we hope that the honor of gathering in the harvest may not pass from our own shores.

July, 1839.

5. "*Transactions of the American Philosophical Society, held at Philadelphia for promoting useful knowledge. Part 2, of Vol. 6, new series (or Vol. 12, of the entire series)*:—p. 155 to p. 337. 4to. *Philadelphia*, 1839.

This part of the Transactions of our most ancient and active scientific body has just made its appearance. It contains several papers of much importance, and well sustains the high character of the Society from which it emanates. We annex a list of all the communications comprised in it.

Art. II. Descriptions of New North American Insects, and Observations on some already described. By [the late] Thomas Say. Continued from Vol. IV, N. S., p. 470. pp. 155—190.

III. Notice of a Vein of Bituminous Coal, recently explored in the vicinity of the Havana, in the island of Cuba. By Richard Cowling Taylor, and Thomas G. Clemson. 191—196.

IV. Observations on the changes of color in Birds and Quadrupeds. By John Bachman, D. D. 197—239.

V. Determination of the Longitude of several stations near the Northern Boundary of Ohio, from Transits of the Moon, and Moon-culminating Stars, observed in 1835, by Capt. Andrew Talcott. By Sears C. Walker. 241—266.

VI. On the magnetic Dip at several places in the State of Ohio, and on the relative Horizontal Magnetic Intensities of Cincinnati and London. By Prof. John Locke. In a letter to John Vaughan. 267—273.

VII. New formulæ relative to Comets. By E. Nulty. 275—295.

VIII. Account of a Tornado, which, towards the end of August, 1838, passed over the suburbs of the city of Providence, in the State of Rhode Island, and afterwards over a part of the village of Somerset. Also an extract of a letter on the same subject from Zachariah Allen, of the city of Providence. Communicated by Robert Hare. 297—301.

IX. Contributions to Electricity and Magnetism, No. III. On Electro-Dynamic Induction. By Joseph Henry. 303—337.

6. *Notice of the "Journal of the Statistical Society of London."* 8*vo.* 18*s. per year.*—This society was established at London in the spring of 1834, and has prosecuted with great vigor the objects for which it was instituted. The journal of the society, (the first number of which appeared in May 1838) is published monthly, and contains an account of the proceedings of the Statistical Society of London, and of other societies, communications on statistical subjects; queries and tabular forms for prosecuting original inquiries; copies or abstracts of parliamentary reports and papers relating to statistics; reviews and lists of new statistical works, &c. The work is in our judgment, one of very great value: as a specimen of the papers contained in it, we may mention the following: Account of the changes and present state of the population of New Zealand; Statistics of the copper mines of Cornwall, England; Statistical Illustrations of the principal Universities of Great Britain and Ireland; Statistical table of crime in Ireland; Moral Statistics of three parishes in the city of Westminster; Account of Algeria, or the French provinces in Africa; Statistics of the city of New York. It is not necessary to say anything here of the importance of authentic statistics to all classes of philosophic inquirers and men of business. To these the work in question cannot fail to be highly acceptable and useful. We hope it may gain a general circulation throughout our country.

7. *Progress of the U. States Exploring Expedition.*—The exploring squadron, of which we have given accounts in Vols. 35 and 36, arrived at Orange Harbor, Terra del Fuego, on the 17th of February, 1839, in forty days from Rio Janeiro. Commt. Wilkes then transferred himself from the *Vincennes* to the brig *Porpoise*, in which, attended by the schooner *Sea Gull*, he sailed from Orange Harbor on the 25th February, 1839, with the intention of penetrating as far south as circumstances

might permit. The *Peacock*, commanded by Lieut. Hudson, attended by the schooner *Flying Fish*, departed at the same time, on a similar voyage, but by a different route. No tidings concerning their success have yet reached us. The *Vincennes*, under command of Lieut. Craven, is to be employed during their absence, in surveying in the vicinity of Orange Harbor. The *Relief*, having on board several members of the scientific corps, was dispatched for a like period, on a cruise through the straits of Magellan, but in making the attempt to enter by the Cockburn Channel, she encountered a succession of violent winds, and about the last of March, narrowly escaped shipwreck in a storm near Noir Island. On this occasion the Relief lost four anchors. For this reason she did not continue the cruise, but sailed for Valparaiso, where she arrived on the 15th April, 1839. Throughout the squadron, health and harmony have prevailed, among both officers and men.

8. *Cold Bokkeveld Meteorites.*—Our last number contained a brief account of the fall of a large meteorite at Cold Bokkeveld, near the Cape of Good Hope, October 13, 1838. By notices in the *Lond. and Ed. Phil. Mag. May*, 1839, it appears that instead of a single meteoric mass, great numbers of stones were thrown down, and according to one statement they were scattered in one line of direction throughout the space of 150 miles. The explosion was "louder and more appalling than the strongest artillery, causing the air to vibrate for upwards of 80 miles in every direction." The following analysis by Sir M. Faraday, of a piece of one of these meteorites forwarded to Sir J. F. W. Herschel, was communicated by the latter to the Royal Society, at its session of March 21, 1839.

"The stone is stated as being soft, porous and hygrometric; having, when dry, the specific gravity of 2.94; and possessing a very small degree of magnetic power irregularly dispersed through it. One hundred parts of the stone, in its natural state, were found to consist of the following constituents, namely:

| | | | |
|---|---|---|---|
| Water, | 6.50 | Alumina, | 5.22 |
| Sulphur, | 4.24 | Lime, | 1.64 |
| Silica, | 28.90 | Oxide of Nickel, | .82 |
| Protox. of Iron, | 33.22 | Oxide of Chromium, | .70 |
| Magnesia, | 19.20 | Cobalt and Soda, | a trace. |

9. *Meteoric Iron from Potosi.*—H. M. Juben, a lieutenant in the French Navy, among other minerals which had been presented to him, brought from Peru a piece of meteoric iron found near Potosi in Bolivia; it was stated to him to be meteoric iron of great purity; it is cavernous, being filled with vacuities, most of which are irregular, but some have the form of a rhombic dodecahedron; some of them also are filled with a greenish vitreous substance similar to the Olivine of Pallas. No traces whatever

of fusion appear, although the mineral evidently indicates the action of a high temperature. The tenacity of this iron is extremely great, but it is readily hammered and filed. It does not oxidize even when exposed to a moist atmosphere. Its specific gravity is 7.736. The mean of three analyses performed by M. Morren give us its composition—

| | |
|---|---|
| Iron, - - - - - - | 90.241 |
| Nickel, - - - - - - | 9.759—100. |

This iron is remarkable on account of the large quantity of nickel; no trace either of copper, cobalt or manganese was discoverable. The specimen is deposited in the museum of Angers.—*Chronique Scientifique,* 24 *Feb.* 1839, in Lond. and Ed. Phil. Mag. May, 1839.

10. *Encke's Comet.*—During its recent return to the perihelion, this comet has been carefully watched by observers in various parts of Europe. At Breslau, it was first detected as early as the 19th of August, 1838, by M. Boguslawski. At Berlin, it was first seen on the 16th of September, and in England and France about the same time. At Marseilles, M. Valz observed with much attention the changes of the comet's dimensions: He estimates its volume on the 10th of October to have been 826 times as great as on 24th of November following. He obtained a view of the body as late as the morning of the 12th of December, two days before its perihelion passage. The differences between the observed and the calculated places of the comet have been found very slight. According to Gautier, they indicate that the mass of Mercury was assumed too large by M. Encke.

11. *Remains of the Mastodon in Missouri.*—In various parts of this vast continent, remains of the *Mastodon* have been occasionally disinterred.* I have recently obtained an uncommonly large, entire, head of the *Mastodon*, together with many of the other bones. The circumstances attending its discovery are these:

A few weeks since, receiving information from a friend that many large bones were found on the land of Captain Palmer & Co., about 22 miles south of St. Louis, I immediately proceeded to the spot; and through the politeness and encouragement of Captain Palmer, commenced operations, which proved more successful than my most sanguine anticipations. The outside formation and peculiar construction of the upper part of the head is different from that of any quadruped in Natural History that I am acquainted with. It is composed of small cells about three quarters of an inch square, and about three inches deep, covered by a thin cranium; attached to the upper jaw is the snout which projects

* We have omitted a few lines in this place as being erroneous in fact, since several entire skeletons have been made up, and an entire head is described and figured in our Vol. 36, page 189.

about eighteen inches over the lower jaw, and which has never been described before.

The position of the tusks in the head, has been a subject of discussion among Naturalists, and they have been placed in the same manner as those of the Elephant. It gives me pleasure to state, that I can now settle this question—for in the head which I discovered, I found a tusk firmly implanted in the socket, and had it conveyed with great care to my museum, but owing to the ignorance and carelessness of a laborer, in carrying it up stairs, it was broken off, but its position can be proved by a number of gentlemen of the highest respectability. The tusks are not situated in the same position as those of the Elephant, as was supposed by some. They diverge outwards from the head with the convexity forward, and the point turning backwards in the same plane with the head; the tusk found in the head measures ten feet one inch, from the base to the tip, following the outside of the curvature, and two feet in circumference near the socket. The other tusk measures only nine feet—part of the roof is wanting. When placed in the head in their original position, the distance from tip to tip, measures sixteen feet. I may add, that it required two stout men to carry the largest tusk, and two yoke of oxen to carry the head and tusks from the place of disinterment to the museum.

Besides the *mastodon's* head, I have found near the same place, several highly interesting remains of antediluvian animals, one of which especially merits attention. It is the head of a nondescript animal, which appears to have been superior in size to the largest elephant, and which resembles somewhat the mastodon in the hind part of the head, but the front part is entirely different; and until it is recognized or proved to have been previously discovered, I shall name it Koch's Missourian, in honor of the State it is discovered in, and intend, in a very short time to give a minute description of it, as well as of a great many relics not herein mentioned.

A. Koch, *Proprietor of the St. Louis Museum.*

St. Louis Com. Bulletin of June 25, quoted in Phil. Nor. Am. July 11, 1839.

12. *Latanium, a new metal.*—Berzelius, in a letter to M. Pelouze, dated Feb. 22, 1839, states that M. Mosander in submitting to analysis the cerite of Bastnaes, in which cerium was met with 25 years ago, has discovered a new metal. The oxide of cerium, separated from the mineral by the usual process, contains nearly two fifths of its weight of the oxide of the new metal, merely altered by the presence of the cerium, and which, so to speak, is hidden by it. This consideration induced M. Mosander to give the new metal the name of *latane* or *lantan.*

It is prepared by calcining the nitrate of cerium, mixed with nitrate of latanium. The oxide of cerium loses its solubility in weak acids,

and the oxide of latanium, which is a very strong base, may be separated by nitric acid, mixed with 100 parts of water.

Oxide of latanium is not reduced by potassium; but by the action of potassium on the chloride of latanium, a gray metallic powder is obtained, which oxidises in water with the evolution of hydrogen gas, and is converted into a white hydrate.

The sulphuret of latanium may be produced by heating the oxide strongly in the vapor of oxide [sulphuret?] of carbon. It is of a pale yellow color, decomposes water with the evolution of hydrosulphuric acid, and is converted into a hydrate.

The oxide of latanium is of a brick-red color, which does not appear to be owing to the presence of oxide of cerium. It is converted by hot water into a white hydrate, which destroys the blue color of litmus paper reddened by an acid; it is rapidly dissolved even by very dilute acids; and when it is used in excess, it is converted into a subsalt. The salts have an astringent taste, without any mixture of sweetness; the crystals are wholly of a rose-red color. The sulphate of potash does not precipitate them, unless they are mixed with salts of cerium. When digested in a solution of hydrochlorate of ammonia, the oxide of latanium dissolves, with the evolution of ammonia. The atomic weight of latanium is smaller than that assigned to cerium; that is to say, to a mixture of the two metals.

Berzelius has repeated and verified the experiments of M. Mosander.—*L' Institut, May* 14, 1839. *Lond. and Ed. Phil. Mag., May,* 1839.

13. *Biography of Scientific Men.*—Professor Webster of Harvard University has nearly ready, from the press, a selection from the biographies of eminent scientific men in Europe, more particularly of those who have largely contributed to the progress of chemical science. The work will comprise translations from the admirable "Eloges" delivered before the French Academy of Sciences, by Cuvier, Arago, &c., and from the memoirs published in the various philosophical Journals and Transactions of other learned societies in Europe. A copious list of the writings of the individuals will be connected with the biography of each, and great facilities be thus afforded to the student for reference to original papers.

The size of the volume will be between four and five hundred pages, and the price not to exceed three dollars. We cannot doubt that this work will prove both valuable and interesting. Few persons in this country can have access to the original sources of information; and Prof. Webster is therefore performing an acceptable service by bringing the history, the labors, and the personal traits of many eminent men before the American public. It is superfluous to add that he will acquit himself with good

judgment and ability; and we wish him that full success which we trust he will obtain as he deserves it well. Subscribers' names will be received by the editor of this Journal, by James Munroe & Co., booksellers, Boston, and S. Colman, 8 Astor House, New York.

The volume will contain biographical notices of—Ray, Priestley, Fourcroy, Wollaston, Cuvier, Leslie, Van Swinden, Knight, Young, Henry, Peron, Hutton, Playfair, Piazzi, Fraunhofer, Breguet, Fourier, Herschel, Pallas, Count Romford, Vauquelin, Volta, &c. &c.

14. *Note by Mr. E. F. Johnson, Civil Engineer.*—In the article in the present number of this Journal, entitled "Mountains in New York," the angular depression of Whiteface Mountain from Mt. Marcy is quoted erroneously from the report of Prof. Emmons at 15′. The depression of 15′ applies according to Prof. E. to Whiteface as seen from Dial Mountain, a high peak situated a short distance S. E. from Mt. Marcy. At the time of writing the article I had not access to the report of Prof. Emmons. The error originated in the use of some rough and imperfect notes in pencil made nearly a year since, and which were in consequence partially defaced. The depression of 15′ of Whiteface from Dial Mt. corresponds very nearly with the difference (234 ft.) in elevation of those two peaks, comparing the height of the latter as given "approximately by levelling', by Prof. E., and the former as determined trigonometrically by myself.

15. *A Northern Lynx taken in Connecticut.*—A wild animal of the genus Felis, was trapped at Southington, Conn., during the night of March 21, 1839, and was shot the next morning by the person who found it in the trap. It weighs thirty-two pounds. Its length is nearly three feet; tail about four inches long and tipped with black. The species to which it belongs is probably the F. *borealis*, Temm., although it does not entirely agree with the description given in Richardson's *Fanua Boreali-Americana.* Further investigation is requisite to settle the species satisfactorily, especially as the Lynxes of North America are not yet well determined. The animal in question, doubtless strayed from the north, and its like is rarely seen within the limits of this State. E. C. H.

16. *Preservation of animal fat for Soap Making, by D. Tomlinson, Schenectady, July,* 1838.—Fat saved for making soap soon passes, especially in hot weather, to a spoiled and offensive condition; sometimes with the loss, in this manner, of the fat, or it is devoured by rats. None of these occurrences happen in my house: nor is the fat boiled in lye to make soft soap. The fat, as it is saved from time to time, is put into a prepared cask, and strong lye is added to it. As it accumulates in quantity, lye is added, and occasionally stirred by a stick. When the cask is full, the soap is already made and ready for use. The lye cask

is filled with ashes for leaching, and the lye is drawn off to add to the soap cask, and more water is added; and thus by filling water and draining, the solution becomes weak, when it is used for bleaching, &c. When the lye cask is emptied, it is filled immediately with ashes, to be used as above mentioned, so that the cask is always in use; by which means it is kept in order, and lasts many years. When left empty, as some persons practice, it shrinks and soon becomes useless. Some quick lime put into the ash cask, near the bottom, causes the lye to be more caustic.

Cedar and white pine make the best casks for lye or soap. The pine should be free from knots and resin, as the lye will incorporate with the resin, convert it to soap, and leave the wood porous and leaky.

When soap has accumulated beyond the wants for soft soap, it is converted into hard soap, by adding one quart of salt to three gallons of soap; it is then boiled and put into tubs, &c., to cool. It is then cut into pieces, the froth scraped off—then melted again to a boiling heat, leaving out the lye at bottom, put it in a box to cool, and cut into bars for drying. A little rosin or turpentine added before boiling, improves the color and quality of the hard soap.

N. B. In winter, the leach tub should be set in the cellar, or where it will not freeze—or, when filled, the ashes should be only dampened with water, not to freeze, and it should stand till spring, before it is leached, to prevent freezing.

I omitted to say, that this mode of making soap relieves from the Pagan practice of boiling soap at a certain state of the moon.

17. *Notice of Vespertilio pruinosus* and Icterus Phœniceus.*—Sir:—I improve this opportunity to inform you that on the 8th inst., (July, 1839,) I obtained in my garden the *Vespertilio pruinosus*, (Hoary Bat,) of Say, and answering perfectly to the description of Dr. Godman in his Natural History, Vol. I, page 68. It is the first instance that I have learned of its being found north of Pennsylvania.† One was captured by Barton some years since near Philadelphia and presented to the museum in that city. "Mr. T. Nuttall also observed it at Council Bluffs." Upon capturing the animal, I found to my surprise, two young ones attached to the breasts of the mother, nearly equal to her in size. It indeed required a number of violent efforts to shake them off, and they then again immediately attached themselves to the breasts of the mother as before. The latter measured 4½ inches in length and 11½ inches in alar extent. The

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* Extract of a letter from Rev. James H. Linsley, to the junior editor, dated Stratford, July 22d, 1839.

† We presume our correspondent has not seen the Journal of the Essex Co. Nat. Hist. Soc. No. ii, where a similar occurrence is recorded Vid. this No. p. 187–8.

young measured each $3\frac{1}{2}$ inches in length and 3 inches across the wings. The old was a light yellow, and the young about the color of the chinchilla, of S. A. I immediately prepared the three for my cabinet, and while so doing, noticed that the stomachs of the young were remarkably distended with milk.

Before I close this article, allow me to add that I have observed the red wing (Icterus Phœniceus) to be carnivorous. No writer that I have seen makes any mention of flesh in describing the food of the *red wing*. A friend assures me that while riding out the first week in June last, he saw a female bird of this species feeding very intently on the ground, and as he passed near she laid hold of something nearly as long as her own body, and made several unsuccessful attempts to rise with it in her bill. It proved to be the skeleton of a bird completely cleaned of flesh, which by a few of the primaries attached to the wings, appears to have been the semi-palmated Ringed Plover.

18. *Malaria.*—Thomas Hopkins, Esq., at the conclusion of a memoir read before the Lit. and Phil. Society of Manchester, England, Nov. 15, 1838, presents the following summary of the effects of water in generating malaria.

It may be presumed that in those parts of the world which have a high temperature, malaria will be found, and especially when the air has been sometime stagnant, in the following situations, viz:

1. Over the open sea. It will be mild here, because the temperature is not very high.

2. Over slowly moving rivers. They will be somewhat more heated by the sun than the sea is, and will therefore evaporate more freely.

3. Over meadows and woods. The great extent of moist surfaces admits of great evaporation from these.

4. Over shallow stagnant water. The temperature of the water will be high, and evaporation consequently great.

5. Over tide sands and muds. These become very hot, and consequently evaporate copiously.

6. Over marshes. These combine great heat, extensive surface for evaporation, and abundant moisture.

The author proposes that hygrometrical, barometrical and thermometrical tables should be kept at various places, in order to judge how far moisture and heat with variations of pressure affect the production of malaria. He gives the following table of mortality to illustrate local agencies on health.

"*A Table of the Deaths per* 1000 *of Strength, and the portion of those who died of Fever, per Annum, of the White Troops in the West Indies, being the average of the returns for the Twenty Years*

*from* 1817 *to* 1836, *arranged in the order of the Mortality. Taken from the Official Report from Twenty-two Stations.*

| | Deaths in 1000. | Deaths by Fever. |
|---|---|---|
| 1. The Bahamas, | 200 | |
| 2. Savannah la Mar, | 200 | |
| 3. Montego Bay, | 178–9 | 150–7 |
| 4. Spanish Town, | 162–4 | 141–1 |
| 5. Tobago, | 152–8 | 104–1 |
| 6. Port Antonio, | 149–3 | 126–0 |
| 7. Up Park Camp, | 140–6 | 120–8 |
| 8. Dominica, | 137–4 | 49–3 |
| 9. St. Lucia, | 122–8 | 63–1 |
| 10. Port Royal, | 113–1 | 93–9 |
| 11. Trinidad, | 106–3 | 61–6 |
| 12. Falmouth, | 102–6 | 80–0 |
| 13. Stony Hill, | 90–2 | 70–5 |
| 14. British Guiana, | 84–0 | 59–2 |
| 15. Lucea, | 84–9 | 63–2 |
| 16. Fort Augusta, | 73–5 | 55–5 |
| 17. St. Kits, Nevis and Tortola, | 71–0 | 42–1 |
| 18. Grenada, | 61–8 | 26–3 |
| 19. Barbadoes, | 58–5 | 11–8 |
| 20. St. Vincents, | 54–9 | 11–2 |
| 21. Antigua and Montserrat, | 40–6 | 14–9 |
| 22. Maroon Town, | 32–7 | 15–3 |

*Lond. and Edin. Phil. Mag., Jan.* 1839."

19. *Electrical Excitement in Leather by Friction.*—The Rev. Thos. Drury, under date of Dec. 17, 1838, at Keighley Rectory, Yorkshire, England, communicates the following fact to Dr. Faraday.

He speaks of what he terms an extraordinary electrifying machine, which is no other than a leather strap which connects two drums in a large worsted mill in the town of Keighley. "The dimensions and particulars of the strap are as follows:

| | |
|---|---|
| It is in length | 24 feet |
| Breadth | 6 inches |
| Thickness | $\frac{1}{8}$ do. |

It makes 100 revolutions in a minute.

The drums, over which it passes at both ends, are two feet in diameter, made of wood fastened to iron hoops and turning on iron axles; these drums are placed at 10 feet distance from each other, and the strap crosses in the middle between the drums, where there is some friction; the strap forming a figure of eight. There is no

metal in connexion with the strap, but it is oiled. If you present your knuckle to the strap above the point of crossing, brushes of electrical light are given off in abundance, and when the points of a prime conductor are held near the strap, most pungent sparks are given off to a knuckle at about two inches; I charged, says Mr. D., a Leyden jar of considerable size in a few seconds by presenting it to the prime conductor. The gentleman who told me of this curious strap has frequently charged his electrical battery in a very short time from it, and he informed me that it is always the same, generating electricity from morning to night without any abatement or alteration. If this strap had the advantage of silk flaps and a little amalgam, it would rival the machine in the lecture room in Albemarle-street."—*Ib.*

20. *Great Scheme for Magnetical Observations.*—The Joint Physical and Meteorological Committee of the Royal Society of London —of which Sir J. F. W. Herschel is president—have agreed to recommend to her majesty's government the establishment of regular observations of the magnetical intensity, dip and variation on the following stations:

In Canada, St. Helena, Van Dieman's Land, Ceylon, and the Cape of Good Hope.

The observations to be made hourly with magnetometers during three years from their commencement.

That on certain selected days, and upon a common plan concerted with each other and with European observatories, "the fluctuations of the same elements shall be observed during twenty-four successive hours, strictly simultaneous with one another, and with intervals of not more than five minutes," &c. &c.

As it is uncertain whether the government will adopt the plan proposed, we omit the remaining details.—*Ib.*

21. *Action of Spongy Platina.*—M. Kuhlmann has described several new reactions determined by spongy platina. Among which are the following:

1st. Ammonia mixed with air on passing at a temperature of about 572° Fahr. over spongy platina is decomposed, and the azote which it contains is completely converted into nitric acid by combining with the oxygen of the air.

2nd. Cyanogen and air, under similar circumstances, occasion the formation of nitric acid and carbonic acid.

3rd. Ammonia, when combined so as to form a salt, acts in the same way as free ammonia.

4th. Free azote cannot in any case be combined with free oxygen, but all the compounds of azote, under the influence of spongy platina, yield nitric acid.

5th. Nitrous and nitric oxides, hyponitric, and nitric acids mixed with a sufficient quantity of hydrogen, are converted into ammonia by their contact with spongy platina, and frequently without even the assistance of heat. The action is frequently so energetic that violent explosion ensues. All the azote of these oxides or acids passes to the state of ammonia, by combining with the hydrogen. An excess of nitric acid gives nitrate of ammonia.

6th. Cyanogen and hydrogen give hydrocyanate of ammonia.

7th. Olefiant gas and excess of nitric oxide, when hot and passed over spongy platina, produce carbonate and hydrocyanate of ammonia and water.

8th. With nitric oxide and excess of the vapor of alcohol, there are obtained under the same circumstances, the same compounds as above, and olefiant gas and a deposite of carbon.

9th. Free azote could not be combined with free hydrogen, but all the compounds of azote were converted into ammonia by hydrogen, either free or carburetted.

10. In the last mentioned reactions, the presence of carbon in combination with azote or with hydrogen, occasions the formation of hydrocyanic acid.

11th. All the gaseous or vaporizable metalloids, without any exception, combine with hydrogen under the influence of spongy platina.

12th. The vapors of nitric acid mixed with hydrogen are totally converted into acetic æther, and water, at a moderate temperature.

M. Kuhlmann remarks that when precipitated platina (noir de platine) is substituted for spongy platina, the action is infinitely less energetic in the greater number of cases, which is the reverse of what might be expected. The precipitated platina has indeed no power in producing nitric acid, it is very weak in producing ammonia, and it never becomes incandescent as happens with spongy platina; but in converting acetic acid into æther, the action of precipitated platina is on the contrary more quick, and produces it even at common temperatures.

It has been subsequently remarked that Berzelius has before stated that when nitric oxide is mixed with hydrogen gas, and the mixture exposed to partly calcined spongy platina, water and ammonia are gradually formed, on account of the union of the hydrogen with both the elements of the nitric oxide.—*Traité de Chimie*, ii, 43—44; *L'Institut*, No. 261—262.—*Ib.*

22. *Formation of Metallic Veins by Galvanic Agency.*—Mr. Fox says, that he has succeeded not only in forming well-defined metalliferous veins in a crack in the middle of masses of clay by means of vol-

taic agency, but also in imparting to the clay a laminated or schistose structure; the veins and laminæ being perpendicular to the voltaic forces. In some instances only a pair of plates, or in preference copper pyrites and zinc, were employed to produce the voltaic action; but a constant battery consisting of several pairs of plates was much more effective. Among the veins thus produced in clay, Mr. Fox mentions oxide and carbonate of copper, carbonate of zinc, oxides of iron and tin. Veins of carbonate of zinc were formed, sufficiently firm to admit of being taken out in plates of the size of a shilling. Mr. Fox then describes a vein formed in pipe-clay, by Mr. Jordan, by five pairs of cylinders, in three weeks. The clay divided an earthenware vessel into two cells, in one of which, containing the copper plate, a solution of sulphate of copper was put; and in the other, or zinc cell, a solution of common salt. Well-defined veins were thus produced of carbonate and oxide of copper, and carbonate of zinc, parallel to the laminæ into which the clay divided; as well as another of carbonate and oxide of copper at right angles to them. On dividing the mass of clay in the direction of the principal horizontal vein, the carbonate of zinc was found on the negative side, or towards the copper plate: and the carbonate of copper nearest the zinc plate: and as the former must have been derived from the zinc plate, it is curious to observe such a complete transposition of the respective metals.

Mr. Fox is of opinion that these results have a strong bearing on the numerous mineral veins and beds which are found conformable to the direction of the laminæ of the containing rocks, as well as on those veins which traverse the laminæ of the conformable veins.—*Ib.*

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### TO OUR SUBSCRIBERS AND READERS.

In No. 73, April 1839, we gave notice that we should publish a duplicate No. in July, and the present No. being the second for that month, appears in fulfillment of our promise. The reason assigned was to avoid linking together two years by the same volume,—that in future we may finish a volume in the last quarter of the year, and begin a new volume with a new year,—thus avoiding a degree of confusion which had been often experienced in the orders for the work. Our subscribers will therefore please, on the appearance of the October No., to pay up to that time, including both Nos. of Vol. 37, and making 5 Nos. instead of 4 for the year 1839. In January, with the appearance of No. 1 of Vol. 38, payment may be made in advance for the year 1840. Thenceforward the Journal year will go along with the calendar year.

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Notices of several valuable works received from authors and publishers are omitted for want of room.

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THE

# AMERICAN JOURNAL OF SCIENCE, &c.

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ART. I.—*Some notice of British Naturalists ;* by CHARLES FOX.

NATURAL HISTORY, like other branches of science, has had its infancy, its childhood, and its maturity. At first and in early times, it observed isolated facts and grouped them promiscuously, without skillful arrangement and classification founded on natural analogies and differences. It has advanced slowly, until in our times it has fallen into the train of the inductive sciences, and now marches onward with confidence and success.

Solomon is the earliest naturalist ; then follows Aristotle, Pliny, and Elian. Of the works of Solomon on natural history, we know little, although he described "Trees from the cedar-tree that is in Lebanon, even unto the hyssop that springeth out of the wall ; and spake also of beasts, and fowls, and of creeping things, and of fishes." It is believed that Aristotle not only had access to his writings, but made great use of them in the compilation of his own works. Natural History was to him a collection of miscellaneous facts ; mingled with much that was doubtful, and still more that was apocryphal : his works evince vast industry in collecting, and a mind well adapted to research. In the words of Mr. Swainson :*

"In his famous book, *Περι Ζωων Ἱστοριας*, he first sought to define by the precision of language, those more prominent and comprehensive groups of the animal kingdom, which, being founded on

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* Cabinet Cyclopædia.

nature, are exempt from the influence of time and the immutability of learning. Had this extraordinary man left us no other memorial of his talents than his researches in zoology, he would still be looked upon as one of the greatest philosophers of ancient Greece, even in its highest and brightest age.

"With peculiar tact he brought the rules of philosophic reasoning to bear upon a subject to that time neglected; upon the extent and depth of his personal researches; upon the clearness with which he arranged his results; and above all, upon those obscure perceptions which he acquired while so employed, of hidden truths which were to be developed only in subsequent ages.

"He discarded from his work all those popular tales, and fancies, and beliefs, which were received by the mass of his countrymen as religious truths sanctioned by antiquity, interwoven in their history and consecrated in their poetry. The death of this great father of the science, was the death of natural history in the Grecian era. The splendor of his discoveries passed like a comet. He left no luminary behind to follow his wake, still less, to throw additional light upon realms which he had but glanced upon."

After nearly four hundred years, Pliny appeared and strove to emulate Aristotle, but without his erudition or genius; his voluminous works are chiefly compilations; they abound in fables and prodigies evincing credulity rather than a disposition to investigate truth; and this is the more surprising, as Rome possessed the most wonderful menagerie that has ever been collected, containing not only lions and other ferocious beasts destined for the circus; but probably all that was rare and curious in more peaceable tribes, since these were often exhibited in triumphal processions. Pliny informs us that Sylla exhibited the terrific spectacle of a combat of one hundred male lions. Cæsar had four hundred, and Pompey had six hundred lions at one time. Natural history now declined in Rome, and with the fables and absurdities of Ælian and one or two others, all records of science expired for nearly fourteen hundred years. Nor was there, A. D. 1500, much more sound knowledge, as regarded the works of the Creator, and the wonders of the earth and of the heavens, than there had been in past ages.*

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* As an instance of the ridiculous extravagancies into which some, calling themselves Philosophers, rushed, even as late as the seventeenth century, we copy the following *actual* Patents, of the period of 1634, as recorded in Ry-

In the sixteenth century appeared—with the revival of learning in England, Lister, Willoughby, and Ray; Belon in Mans; Rondelet in France; Saleciani in Rome; Gesner in Germany, Aldrovandus in Bologna, and others, producing among them important works on the leading branches of natural history.

The end of the sixteenth, and the beginning of the seventeenth centuries, were signalized by rapid advances in knowledge. The art of printing, now come into general use, and the reformation, now fully established,—the former by extending and making more common all kinds of knowledge, the latter by freeing the minds of men from that thralldom in which they had so long been held,—prepared, if they did not force the way, for a vigorous and successful emancipation of the human mind. Men, remarkable for the freshness and grasp of their intellect, arose, both on the continent, and in England; and not afraid of the name of reform, they carefully scrutinized all the information and theories which they had received from their fathers, and boldly cast aside all which they did not find to be true.

Our present improvement and progress in science we owe primarily to England. It was there, about 1600, that Lord Bacon the father of natural science, arose. To that country, and to that master-mind, we are indebted for the logical precision which alone could direct our steps in the search after truth: and it is this period which we must mark as the *new era* in natural science. As the rising sun dispels the mists and fogs of the morning, so did the brightness of his exalted mind illuminate the darkness around.

The object of this paper is to give a sketch of the progress of natural history—limiting it, for the present, chiefly to the higher orders of Zoology in Great Britain. We shall, therefore, now

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mer's *Fœdera*: "The *Fish-call*, or a looking-glass for fishes in the sea, very useful for fishermen to call all kinds of fish to their nets, seins, or hooks." "An instrument which may be called the *Windmate*, very profitable, when common winds fail, for a more speedy passage of calmed ships and vessels on seas and rivers." "A moveable *Hydraulic*, or chamber weathercall, like a cabinet, which being placed in a room, or by a bed side, causeth sweet sleep to those who, either by hot fevers, or otherwise, cannot take rest; and it withal alters the dry, hot air, into a more moistening and cooling temper, either by musical sounds, or otherwise." These patents were for fourteen years, and paid £1 6*s.* 8*d.*, yearly to the Exchequer.—*See Life and Adminis. of Edward, first Earl of Clarendon, by H. T. Lister, Vol. I, p. 23, note.*

confine ourselves to that portion of the world; with an occasional glance, but only incidental, at other countries, as our plan is restricted within narrow limits. We shall at the same time, give short sketches of the lives of such as have been peculiarly devoted to this science, *for its own sake.* In this view, science is in our utilitarian age more neglected in the present, than in some former periods of its history. Men are too much taken up in attempting to promote the *minor* arts. The *philosophical* spirit is too much banished; that spirit, which Bacon has characterized as the germ of life in the sciences. Hoping to be ourselves guided by this spirit, we shall not however abstain from introducing apposite proofs of the usefulness of the knowledge and study of natural history.

The state of science towards the close of the sixteenth century, presented a field of observation singularly calculated to attract the curiosity and awaken the genius of Bacon.

"One of the considerations which appears most forcibly to have impressed itself upon his mind, was the vagueness and uncertainty of all the physical speculations then existing, and the entire want of connection between the sciences and the arts. Those things are in their nature so closely united, that the same truth which is a principle in science, becomes a rule in art; yet, there was at that time hardly any practical improvement which had arisen from a theoretical discovery. The natural alliance between the knowledge and the power of man, seemed entirely interrupted; nothing was to be seen of the mutual support which they ought to afford the one to the other. The improvement of art was left to the slow and precarious operation of chance, and that of science, to the collision of opposite opinions."*

To use Bacon's own words in his *Advancement of Learning*: "As things now are, if an untruth in nature be once on foot, what by reason of the neglect of examination, and countenance of antiquity, and what by reason of the use of opinion in similitudes and ornaments of speech, it is never called down."

But there was still another circumstance which, in a peculiar manner, attracted his attention—the neglect then prevalent of ordinary, and the thirsty zeal for extraordinary objects. What is immediately before us, and of every day occurrence, however

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* Professor Playfair.

important and interesting it may be in its peculiar features, we are apt to neglect and overlook. That which is rare, and is seldom observed, excites an active investigation. And thus it was that the philosophers of old, in their pursuit of natural science, applied their chief attention to phenomena, and left the more general laws of physics uninvestigated. Nobody sought to know why a stone falls to the ground; why smoke ascends; or why the stars revolve around the earth; while the discovery of a double-headed snake, or a deformed bird, excited the warmest interest, and the approach of an African seal to the shores of Europe, revived the fable of a mermaid. But the natural consequence of this neglect of common, and of minute attention to the extraordinary occurrences, was to render it impossible to establish any general or useful principles, and still further, to deduce any general laws. It is a beneficial rule of the Creator, that that which is in nature most *truly* valuable, should be the easiest of access; and it is in the properties of such things as exist familiarly around us, that we must look for the explanation of what seldom occurs.

To quote again from Bacon, in a passage which contains the germ of much of his *Novum Organum:* "So it cometh often to pass, that mean and small things discover great, better than great can discover the small: and therefore Aristotle noteth well, 'that the nature of every thing is best seen in its smallest portions,' and for that cause he inquireth the nature of a commonwealth, first in a family, and the simple conjugations of man and wife, parent and child, master and servant, which are in every cottage. Even so likewise, the nature of this great city of the world, and the policy thereof, must be first sought in mean concordances and small portions. So we see how that secret of nature, of the turning of iron touched with the loadstone towards the north, was found out in needles of iron, and not in bars of iron."

Notwithstanding, however, this well merited compliment to the Aristotelian philosophy, as regards *Natural Science*, this course is imperfect and deceptive. It has culled a few from a great many things; it has taken its principles from common experience, and without due attention to the evidence or precise nature of the facts; the philosopher is left to work out the rest from his own invention.

Like Luther before him, his great predecessor in the work of reform, although in another sphere, Bacon bore a strong enmity

to what *then* went under the title of Aristotelian philosophy. It was indeed little better than an eclectic system, passing under that great name, mingled with the dogmas of Popery, and was in a great measure devoted to the propagation and support of trivial arguments or positive error. Bacon was not unacquainted with the writings of Aristotle; for in those days, to be well educated, was to be an adept in his system; but his acute discrimination soon perceived, that however well adapted, this system was to act as a guide in some branches of knowledge; it was wholly unfit for the investigation of *natural* science; and in this respect, was but the blind leading the blind.

Bacon cannot indeed be said, *in toto*, to have originated the inductive philosophy, for Aristotle himself does both use it and recommend its adoption in certain cases. It is, in truth, founded in the very nature of man's intellectual powers, in the very fitness of things. But he culled it forth from the mass of facts and speculations where, hitherto, it had lain concealed and neglected; he applied it where it had never been applied before, and, in this respect, too great a degree of praise cannot be awarded to him. If not an inventor, he stands at least next to that place of honor; and we know not but that the new and just application of old and venerable principles to new positions, demands a genius more energetic and more subtle than his who first struck upon the vein of thought. Few have power; fewer still have courage to interfere with opinions rendered venerable by antiquity, or supported by high and noble names. It is by this *application* of mind to matter, that mind becomes truly predominant, and claims to itself its high and commanding rank among created things, and its mastery over matter.

Although Bacon pointed out to all succeeding naturalists the course which they ought to pursue in their researches, he was himself no naturalist. He was the commander of the host, but he did not himself march at their head: he was by far too much occupied with his investigations of the laws of mind and matter to be able to pay any minute attention to the particulars; and what he has left behind under the name of "*Natural History*," is rather intended as an example to his successors, than as a work of absolute profit. The great principle for which we are indebted to him, was from the observation of a large body of physical facts to deduce general laws, not by theorizing, but by steady and stern induction.

"As things are at present conducted," says he, "a sudden transition is made from sensible objects and particular facts, to general propositions, which are accounted principles; and around which, as around so many fixed poles, disputation and argument continually revolve. From the propositions thus hastily assumed, all things are derived, by a process compendious and precipitate, ill suited to discovery, but wonderfully accommodated to debate. *The way that promises success is the reverse of this.* It requires that we should generalize slowly, going from particular things to those which are but one step more general, from those to others of still greater extent; and so on to such as are universal. By such means we may hope to arrive at principles, not vague and obscure, but luminous and well defined, such as nature herself will not refuse to acknowledge." The end of all knowledge is utility, the improvement of the condition of mankind; and vain must that species of it ever be which revolves within itself, and has in view no ultimate effects.

It was not long before his works began to take effect among thinking men. Truth advances slowly; especially when long established errors oppose its progress; but still, there are always in society a certain number of persons, who, standing on a higher eminence, like the Hebrew sentinels of old, receive the first gleams of light, and inform those below of the fact. Bacon awakened a spirit of inquiry; and the minds of men began to be opened to the absurd fables of ancient authors, and to cast aside the interminable synonyms which obscured, while they were meant to elucidate natural history.

The first whom we may rank in the new school of British naturalists was John Ray, or Wray, for he wrote his name in both ways. He was born in 1628, at Black Notley, near Braintree, in Essex; a small and picturesque country hamlet, but remarkable for nothing else, we believe, except as being the birth place a few years before of the celebrated William Bedell, bishop of Kilmore, in Ireland; a man equally remarkable for his piety and moderation; and respected and well treated by even his opponents and enemies.

Ray was the son of a blacksmith, who, from the little we can learn of him, appears to have been in his station, a person of sober habits and respectability, and to have amassed sufficient property to give his son a good education. Of the early years of the

naturalist we know nothing. Interesting as an account of this period in general is, as giving some evidence of future activity and eminence, it is too often lost for want of a record; and this especially in the station in which young Ray's early life was past. He was when a boy sent to a classical school at Braintree, and at the age of sixteen he entered, as a commoner, at Katherine Hall, Cambridge. Not being, however, satisfied with this college, he was soon transferred to Trinity, where, in the usual course, he took his degree. His abilities were certainly good; and he was remarkable at this early period for his proficiency in the knowledge of the learned languages. He was likewise very industrious; and being aware of the value of time, he carefully gathered up the fragments of it; and was able to accomplish not a little, besides the usual routine of study. And here he soon manifested his taste for natural history. Botany first attracted his attention. Like Lord Bacon, he was extremely fond of flowers; and he collected and examined what he met with during his walks for recreation. As this was his first love among the works of God, so was it always his strongest passion, and predominant over that for all other departments of nature. His abilities soon attracted attention in the university. In succession he became a Fellow of Trinity College; Greek and Mathematical Lecturer, and Reader in Humanity, besides holding several other offices. Not only was he an eminent tutor, but likewise a distinguished preacher. Theology was a favorite study of his; and he brought the books of revelation and of nature respectively to bear the one upon the other. He was not however ordained at this time; for, during the disorders of the Commonwealth, the ministerial office was as generally held by persons not in orders as the contrary. While thus diligently pursuing his graver duties, he found time, in 1660, to publish his first work on natural history—*a Catalogue of Cambridge Plants*, in the arrangement of which he was much assisted by a friend of the name of Rid. It is neither the power of intellect, nor the brilliancy of genius, which is the peculiar honor of man; but the soundness of his judgment, the strength of his moral feelings, and the warmth of his affections. Without these latter the former are, as they concern himself, mere baubles; trusts committed to him, it is true, but which he wants the power properly to use. And we may here remark upon what appears to have been a distinguishing

part of Ray's character, his admiration for friendship, and his cherishing of his friends. We never find him alone. Is he writing a book? Some friend assists him in collecting the details. Is he making a tour to increase his stock of knowledge? Some brother in feeling is his constant companion. Is he engaged in editing the works of another? He is performing the last melancholy duty for one who never forsook him, either in prosperity or adversity.

This work may be said to be the beginning (of any importance) of the publication of *local floras;* a branch of literature which has been of late so successfully cultivated; and which has had more effect in ascertaining and fixing this part of the natural history of Great Britain, than even the writings of more scientific and learned authors. And it is greatly to be desired that it were more thoroughly prosecuted than it has hitherto been, in this our own land. Not only do we want such accounts of plants, but likewise of all the different departments of nature. From such sources the great and commanding writers draw their information; and if these minor springs run dry, we cannot possibly expect any truly important results. It was in this way that the great Cuvier himself began, when engaged in his investigations of the inferior animals, while a tutor in Normandy; and he owed not a little to it in after life. Each district has its own peculiarities which are easily observed by those who live there; and thus to collect information will ever be found a labor which is fully repaid by the pleasure which accrues from it. To make it public may cost more pains; but magazines and journals are always ready to notice any important fact or observation. Previous to this time botany had been much neglected over the whole of England; but this publication of Ray gave it a new spring, and set up a model of what might be effected by others. In Ray's own words, "many were prompted to those studies, and to mind the plants they met with in their walks in the fields." He had now hit upon a path along which his genius pointed, and for the following of which his peculiar talents fitted him. Having once begun, he eagerly pursued his researches; and not content with what he met with in the neighborhood of Cambridge, he extended his investigations throughout the greatest part of England and Wales, and the south of Scotland. In these tours, for he was only absent at intervals, he was generally accompa-

nied by Willoughby, whose various works on the subject are well known, and whose fondness for nature was equal to his own.

Of these short journies he kept journals, which were afterwards published under the title of *Itineraries.* They contain little that is of general interest; and are curious chiefly from the account which they give of the state of the roads and towns at that period.

The restoration of king Charles II, bringing with it a return to old manners and customs, and more peaceful times, Mr. Ray determined to enter into holy orders. For this, as we have seen, his previous education had been such as fully to prepare him; and in December, 1660, he was ordained both deacon and priest, by Dr. Sanderson, bishop of Lincoln. He however still remained at the university, engaged in his previous duties, without any fixed cure of souls. In 1662, came the celebrated Bartholomew act; and as, from conscientious motives, he refused to sign the declaration, he lost his fellowship and other offices. From what sources he now derived his income does not appear. Whether his father had been enabled to leave him any property, or whether his previous college appointments had been so lucrative as to enrich him sufficiently, none of his biographers mention. He however immediately set off, with a party of three, for a scientific tour upon the continent, whence he did not return till March, 1665; and till, in conjunction with Mr. Willoughby, he had collected a large number of miscellaneous specimens of natural history. Then began his great labors; and those in which the order and strength of his mind are peculiarly perceptible.

Bishop Wilkins had for some time previously occupied his leisure in the study of botany; and for the next two years, Ray was engaged with him in classifying the plants of England; and in throwing them into a natural arrangement. With his first plan, as he informs us in his preface to the *Synopsis methodica Stirpium Britannicarum,* he was not altogether satisfied; and, as was very natural on a subject so truly new, he perceived many errors. In this trait, however, it is not difficult to trace the germ of his future eminence.

Far as he had proceeded beyond all previous writers, he could not be contented till he had attained the utmost excellency which his imagination held out before him; and instead of sitting down quietly to rest, one labor was but the precursor of another still

greater. These errors he by degrees corrected, and laid the foundation of that natural system which was so long afterwards adopted. In 1667, at the age of thirty-nine, he was admitted a member of the Royal Society of London, at that time no small honor, and no little profit to the mind, as the greatest philosophers of the day were its active members; in 1670, he published the first edition of his *History of British Plants.*

From this period his life passed quietly away. The man of science lives much by himself. He converses with nature: free from the turmoil and anxieties of the world, his days are rather marked by the progress of his discoveries in knowledge, than by any thing which can interest the general reader. He gradually became more celebrated as a naturalist; and being still a person of most industrious habits, his writings accumulated. Among other subjects which engaged his attention at this time, we find that he was actively employed in investigating the phenomenon of the circulation of the sap in trees, the discovery of which was reserved for later times, and a deeper knowledge of the principles of mechanical science. His writings are contained in about twenty volumes. They have never been collected, and many of them are now very scarce and difficult of attainment. Besides his volumes on botany, which form nine independent works, he edited the writings of his friend, Mr. Willoughby; published his own travels both in England and on the continent,—the most remarkable topic in the latter of which is his description of *locks* for canals, which appear to have been then quite novel,—a collection of unusual or local English words; the same of proverbs; a dictionary of three languages; a persuasion to a holy life; the wisdom of God manifested in the works of creation; Physico Theological discourses, with practical inferences; two volumes on insects, and some minor volumes and papers.

With a glance at his private life we shall conclude this sketch.

After his return to England he appears never to have officiated as a clergyman; but to have resided where his fancy led him, or the society of his friends induced him. In 1672, he met with a heavy affliction in the death of his old and constant friend, Mr. Willoughby. This gentleman left him by his will, property to the amount of £60 per year, and bequeathed to his care the education of his two sons. The younger one afterwards became the first Lord Middleton. Thus occupied he removed to Middleton

Hall, where he staid, in all, about four years; and he appears to have acted, not only the part of a valuable tutor, but of an indulgent guardian and kind parent to his charge.

"In 1673," says his biographer, "having lost some of his best friends, and being in a manner left destitute, he began to have thoughts of marriage; having met with a young gentlewoman, (then in the family he was in,) of about twenty years of age, whose piety, discretion, and virtues, as well as her person, recommended her to him." Her name was Margaret Oakeley, of an Oxfordshire family. They were married in the May following, and he never appears to have had occasion to repent of his choice.

In 1679, having parted with his pupils, with an affection for the place of his birth, he removed back again, as his years were increasing, to Black Notley. Here for ten years he resided, being actively engaged in writing, till in 1687, his health failed; he became infirm, and he died, worn out, in 1704, in the seventy-sixth year of his age. He was buried in the Parish church, and a monument was erected to his memory by his friends.

A good fame is the peculiar possession of the dead; and with all his faults, few appear, in those busy times, to have left behind them a more unsullied name. If we may judge from the high station which he held in Cambridge, and from the internal evidence of his works, he was a fine scholar, and possessed of both descrimination and taste. Contemplation rather than action was the peculiar form of his mind; but he wanted not activity, and certainly was of a restless and most inquiring turn. While anything was to be learned, which he thought it worth while to employ himself upon, he allowed no difficulties to dishearten him and no self-denial to prevent his pursuit. And we may here make a general observation, that however much it may please some to disparage the study of natural history, or to declare it to be only fit for trifling and inferior minds, we not only see in this case, but in all others, that eminence in this science is of peculiar difficulty of attainment. The highest powers of judgment, of research, and of perseverance are necessary; and it has seldom been reached, where general learning and a well regulated education have not previously prepared the mind. Considering the numbers who have attempted it, there are fewer who have made any real progress in this, than in any other of the pursuits of mankind.

Of his goodness of heart we have already had occasion to speak. A child-like simplicity seems to have been a prominent point in his character; and he enjoyed the society of those whose minds were of a humble and inquisitive nature. His friendships were unalterable; and his course in life was marked by an absence of quarrels, and the love of those connected with him. In 1682, he was led into dispute with Tournefort and Rivinus. Literary controversy is but too often the offspring of arrogance and folly on one side or the other, and seldom leads to any other result than to leave each champion the more strangely convinced of the truth of his own opinion. Ray was soon sorry for it and gave it over. "The contentious way of writing was by no means agreeable to his sweet and peaceful nature, who, as he loved all men, so desired to be at perfect peace and unity with all." It is perhaps to be lamented, that having voluntarily entered into holy orders, he should so entirely have forgotten the vows which were upon him, as not afterwards to have officiated; and we can only account for it from the fact of his being in a measure prevented by the Bartholomew act, and by the bent of his mind leading him, weakly leading him perhaps, to other pursuits. Had he made natural history a *part* of his studies while prosecuting his still more important profession, all honor would have been due to him; but as it is, we can only be sorry that his course in this respect was not different. In the words of one who knew him well, we conclude: "In his dealings no man was more strictly just; in his conversation no man more humble, courteous, and affable. Towards God no man more devout. Towards the poor and distressed no man more compassionate, and charitable according to his abilities."

He was but a man, and as such but weak and fallible. In his works his piety is predominant. He never forgot that he was occupied in searching the wonders of his God; or that his labors were to tend to his honor and glory: and thus it is that where science becomes the handmaid to religion, she is in her appropriate sphere and is all glorious; but that when she descends from this her proper place, then her form is polluted, and her influence worse than evil.

Did we not confine ourselves especially to the writers upon *British* natural history, the name of Willoughby, the friend of Ray, would be deserving of high and honorable mention. He was then in a great measure to zoölogy, what Ray was to bot-

any; but he included in his writings, species from all countries. His chief works on birds and on fishes—which are still valuable from the correctness of the plates—he did not live to finish, and they were edited and published by Ray. Of his character, a biographer thus speaks:

"And now, having mentioned the diligence of this great man, let me add that it was such, and his labors so incessant in studies, that he allowed himself little or no time for those recreations and diversions which men of his estate and degree are apt to spend too much of their time in; but he prosecuted his design with as great application as if he had been to get his bread thereby. All which I mention not only out of the great respect I bear to Mr. Willoughby's memory, but for an example, as has been before recommended to persons of great estate and quality: that they may be excited to answer the ends for which God gives them estates, leisure, parts, and gifts, or a good genius, which was not to exercise themselves in vain and sinful follies; but to be employed for the glory and in the service of the infinite Creator, and in doing good offices in the world, especially such as tend to the credit and profit of their own families."

**(To be continued.)**

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ART. II.—*On the Natural History of Volcanos and Earthquakes*,* by Dr. GUSTAV BISCHOF, Professor of Chemistry in the University of Bonn. Communicated by the Author.

I. *Are volcanic phenomena capable of a satisfactory explanation from the increase of temperature towards the centre of the earth, or can chemical processes be admitted with greater probability to be the cause of volcanic action?*

ON inquiring into the cause of volcanic phenomena we must not forget, says Von Humboldt,† that the arrangement of volcanos sometimes in circular groups and sometimes in double lines, is the most decided proof that their action is not dependent on

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* From the Edinburgh New Philosophical Jour., Vol. XXVI, No. 51, Jan. 1839.

† On the structure and action of volcanos in various parts of the earth, in the Abhandlungen der Königl. Acad. d. Wissensch. zu Berlin, 1822 and 1823, p. 137, and in Jameson's Phil. Jour. vol. v. p. 223.

any trifling causes, lying near the surface, but that they are vast and deeply-seated phenomena. Thus, for example, the whole of the high country of *Quito* is one volcanic hearth, of which the mountains of *Pichincha*, *Cotopaxi*, and *Tunguragua*, form the summits. The subterranean fire breaks out sometimes from one, sometimes from another of these vents, which are usually considered as distinct volcanos. The earthquakes, with which *America* is so dreadfully visited, are also remarkable proofs of the existence of subterranean communications, not only between countries free from volcanos, as has been long known, but also between volcanic hearths situated at a great distance from each other. All these circumstances prove that the forces do not act at the surface of the crust of the earth, but that, proceeding from the interior of our planet, they communicate contemporaneously by fissures with the most distant points on the surface.*

Two hypotheses may be proposed respecting the causes of volcanic phenomena. The one supposes them to be occasioned by intense chemical action taking place between bodies having a very great affinity to each other, and by which so great a heat is produced, that lavas melt and are forced to the surface of the earth by the pressure of elastic fluids. According to the other, the earth at a certain depth is at a white heat, and this heat is the chief cause of volcanic phenomena.

1. *The hypothesis, which ascribes volcanic phenomena to intense chemical action, shewn to be untenable.*

We will not detain our readers, with an account of the earlier hypotheses, which derive volcanic phenomena from the action of iron upon sulphur, or from the combustion of pyrites or coal, as their insufficiency is self-evident. But Davy's discovery of the metallic bases of the alkalies and earths was considered as throwing a great light on this subject.

This distinguished philosopher, who instituted some very interesting experiments at *Vesuvius* during its eruptions in 1814, 1815, 1819, and 1820, endeavored to explain the phenomena by the oxidation of the metals of the alkalies and earths.† He

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* Von Humboldt's Reisen in die Æquinoctial Gegenden des neuen Continents, t. i, p. 496, t. iii, p. 24, 26, and 40, offer many instances of this kind.

† Sur les Phenomenes des Volcans. Annales de Chim. et de Phys. vol. xxxvii, p. 133.

thinks himself justified in supposing the caverns beneath the *Solfatara* of *Puzzuoli* to have a subterranean communication with *Vesuvius*, because whenever the latter is in action, the former is in repose. A slip of paper which Davy threw into the mouth of the *Solfatara*, during an eruption of *Vesuvius*, was not rejected, from which he concluded that there must be a descending current of air. The subterranean thunder, which is heard at such great distances from beneath *Vesuvius*, seems to him to indicate the existence of great subterranean caverns, filled with gaseous substances, and that the same caverns which, during the activity of the volcano, continue for a long time to eject enormous quantities of aqueous vapor, must be filled, during its repose, with atmopheric air. In proof of the existence of extensive caverns, he mentions those in the limestone of Carniola. Now, as the metals of the earths in the supposed volcanic caverns are not only exposed to the action of the air but also to that of aqueous vapor, they will be oxidized at the expense of both, and be converted into lava. He thinks his hypothesis capable of explaining all the phenomena which he observed.

Davy also touches upon the circumstance, often mentioned by geologists, that almost all great volcanos are situated near the sea.* Supposing their first eruption to have been caused by the action of the sea-water upon the metals of the earths, and the metallic oxides, ejected from the craters in the form of lava, to have left vast caverns, the succeeding eruptions would be effected by the oxidations which would ensue in those caverns. Davy is of opinion that when volcanos lie at a distance from the sea, as those of *South America*, the water may be furnished from subterranean lakes; for Von Humboldt asserts that some of these volcanos cast up fish.

If we wish to ascribe volcanic phenomena to chemical action, says Davy, the oxidation of the metals of the earths and alkalies

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* That volcanos may act at a great distance from the sea is proved by the *Pesckan* in the centre of *Asia*, which is 260 geographical miles distant from any great sea, and from which streams of lava have issued within the period of our history. Even the opinion that the vicinity of extensive lakes operates on the volcanos of *Central Asia*, in the same manner as the ocean, is unfounded. The volcano of *Turfan* is surrounded by very inconsiderable lakes, and the Lake of *Temartu* or *Tssikul*, which is not twice as large as the *Lake of Geneva*, lies fully 25 geographical miles from *Pesckan*. See also Girardin in opposition to Davy's hypothesis in Jameson's Phil. Journ. vol. ix, p. 136.

merits our attention in preference to any other process. He himself, however, observes, that the observations in mines and in hot springs seem to indicate, with some degree of probability, that the interior of the earth possesses a very high temperature, and that, if the earth's nucleus be supposed in a state of fusion, the explanation of volcanic phenomena is simpler than according to his own theory.

Gay-Lussac very justly remarks, that it is impossible to conceive the admission of atmospheric air into the focus of volcanos, as there must be a force within them acting outwards, by which the liquid lava, a substance about three times as heavy as water, is raised to a height of above 3000 feet, as at *Vesuvius*, and more than 9000 feet in many other volcanos. A pressure of 3000 feet of lava, equal to that of a column of water of 9000 feet high, or to about 300 atmospheres, necessarily prevents the entrance of air into the interior of the volcanos; and as this pressure continues for many years, during which time the phenomena by no means abate in activity, it is impossible that air should in any way contribute to it.

The presence of water in volcanos during the various stages of their activity is, on the other hand, a circumstance repeatedly witnessed by all observers.* Even the smoking during their intervals of repose is, for the most part, nothing but a disengagement of aqueous vapor. Violent eruptions are not unfrequently followed by such enormous quantities of steam, that it condenses in the atmosphere, and falls in heavy showers, as was the case after the memorable eruption of *Vesuvius*, which destroyed *Torre del Greco* in 1794.† Among the elastic fluids evolved from volcanos, besides aqueous vapor, we frequently find sulphuretted hydrogen gas, as, for example, from those at the equator; and from others, as *Vesuvius*, muriatic acid gas. But the formation of these gases in the interior of volcanos cannot be conceived without the presence of water.

If the oxidation of the earthy and alkaline metals were to take place at the expense of water, enormous quantities of hydrogen

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* See, among others, Monticelli and Covelli, der Vesuv. Deutsch bearbeitet von Nöggerath and Pauls. Elberfeld, 1824, p. 157.

† See von Buch's geognostiche Beobachtungen, tom. ii. 152. There is, however, still another cause, which occasions these heavy showers, as we shall shew afterwards.

would be necessarily evolved during volcanic eruptions. But this gas seems never to issue from volcanos. According to the observations of Breislak,* Spallanzani,† Monticelli and Covelli,‡ Hoffmann,§ and Poulett Scrope,‖ flames are never seen to rise from the crater of *Vesuvius*. Neither did Gay-Lussac¶ during his stay at Naples in 1805, during which he was a frequent witness of explosions, which raised the fluid lava to a height of above 600 feet, ever observe a combustion of hydrogen gas. Each explosion was accompanied with dense black columns of smoke, which would have inflamed, had they been composed of hydrogen gas, as they were traversed by bright red-hot masses. According to Boussingault, neither hydrogen, muriatic acid gas, nor nitrogen gas, is evolved from the volcanos, under the equator, in the New World.** In opposition to this evidence, we have the assertions of Von Buch.††

Davy's hypothesis does not account for the exhalations of carbonic acid gas (Mofettes,) which not only succeed every eruption of *Vesuvius*, but also occur in the vicinity of extinct volcanos and in places affording unquestionable traces of former volcanic action (*Auvergne*, *Vivarais*, *Eifel*, *Laacher See*, *Bohemia*, and so forth‡‡,) in amazing quantities, and as far as we can learn from history, with uninterrupted uniformity. These phenomena must necessarily be closely connected with volcanic action, and cannot pass unnoticed.

But these disengagements of cabonic acid gas could not take place in the presence of atmospheric air in those vast subterranean cavities without their mixing together. Yet, according to Monticelli and Covelli,§§ the Mofettes of *Vesuvius* contain but little atmospheric air, which seems not to intermix with the carbonic acid gas until it reaches the surface. I have examined many such exhalations of carbonic acid gas, in the vicinity of extinct volcanos, (in the neighborhood of the *Laacher See* and in the

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* Lehrbuch der Geologie, transl. into German by Strombeck, vol. iii, p. 117.

† Voyages dans les Deux Siciles, etc. vol. ii, p. 31. ‡ Loco cit. p. 191.

§ A personal communication. ‖ Considerations on Volcanos. London. 1825.

¶ Loco cit. p. 420.

** Ann. de Chim. et de Phys. t. lii, p. 23. †† Loco cit. t. ii, p. 141.

‡‡ Monticelli and Covelli, l. c. p. 191. Bischof and Nöggerath in Schweigger's Journ. v. xliii, p. 28. Bischof in Schweigger-Seidel's Journ. v. xxvi, p. 129. The same in his Vulcanischen Mineralquellen. Bonn. 1826. p. 251. Von Buch in Poggendorff's Ann. v. xii, p. 418. §§ Loco cit. p. 194.

*Eifel,*) as well as in places where there are no immediate volcanic traces, (*Hundsrück*, the eastern declivities of the *Teutoburger Wald,*) and, in general, have found a scarcely measurable quantity of atmospheric air. According to Boussingault,* the elastic fluids, which are evolved from the volcanos at the equator in the New World, consist of a great quantity of aqueous vapor, carbonic acid gas, sulphuretted hydrogen gas, and sometimes fumes of sulphur; he considers sulphurous acid gas and nitrogen, on the other hand, as accidental. This philosopher† also found the same gases, viz., carbonic acid and sulphuretted hydrogen gas, in the springs which rise in the vicinity of these volcanos. All this is by no means favorable to the supposition of the existence of vast subterranean cavities filled with air under the craters, and an equally unfavorable circumstance is, that, according to Boussingault, no nitrogen is evolved from the volcanos under the equator, which must necessarily be the consequence of oxidation at the expense of atmospheric air.

Independently of all this, the metals of the earths have been found by more recent experiments to be by no means so easy of oxidation as Davy's hypothesis assumed. Besides, this proneness to oxidation must be supposed to be a property more especially belonging to the metals of silica and alumina, as these earths together with oxide of iron, are the principal components of volcanic products—lavas, basalts, &c., generally amounting to about 0.8, whilst lime and alkalies, although never entirely wanting, form but an inconsiderable proportion. But Berzelius‡ has shewn, that silicium, the combustible base of silica, when freed of hydrogen by being gradually heated to a white heat, is incombustible even at that heat in the air or in oxygen; and that it is equally incapable of decomposing water. In like manner Wöhler found,§ that aluminum, the metallic base of alumina, is not oxidized under a red heat, and decomposes hot water but very slowly, while on cold water it has no influence whatever.

Therefore Davy's hypothesis would be applicable only to the metallic bases of alkaline earths and alkalies. But, as these occur only in small proportions in the volcanic rocks, it is scarcely conceivable that so much heat should be evolved by their com-

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* Loco cit. v. lii, p. 5. † Ibid. p. 181. ‡ Poggend. Ann. v. i, p. 221.
§ Poggend. t. xi, p. 146.

bustion at the ordinary temperature as would be sufficient to melt the pure earths, or to inflame their metals, supposing them to exist at the seat of the volcanic action.

The slight specific gravity of the metals of the alkalies, also proves fatal to Davy's hypothesis; for, if the mean density of the earth surpass that of all kinds of rocks, those metals cannot exist, at least not in great quantities, in the interior of the earth.* Davy's hypothesis, therefore, according to the present state of science, will not account for volcanic phenomena.†

Gay-Lussac,‡ assuming that water supplied the oxygen in volcanos, endeavored to account for the absence of uncombined hydrogen among the exhalations of volcanos, by supposing it to form such combinations with other bodies as would not inflame by coming into contact with the air. This is the case when it combines with chlorine to form muriatic acid gas. He here refers to the observations of Breislak,§ and of Monticelli and Covelli,‖ which shew that this acid is among the exhalations of volcanos. He himself, however, observes, that an enormous quantity of muriatic acid must be evolved from the craters, if the hydrogen, which would result from an oxidation by means of water, were to enter into combination with chlorine. But it would be strange that such an exhalation should not have been remarked sooner. In order to account for the formation of muriatic acid, he mentions the experiments made by him and Thénard, in which they evolved that acid, by introducing aqueous vapor into a mixture of sand and common salt heated to a red heat. In support of his position, he mentions the occurrence of common salt in the lavas, from one of which, (that of *Vesuvius* in 1822,) Monticelli and Covelli extracted more than 0.09, and in the slags which cover the white hot lava, and which sometimes contain very beautiful

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* Also the latest experiments, made with admirable exactness by Prof. Reich in *Freiberg*, with the assistance of the torsion-balance, have given 5 44 for the density of the earth, as a mean of 14 experiments which afforded very nearly the same results. Versuche über die mittlere Dichtigkeit der Erde mittelst der Drehwage von F. Reich. Freiberg, 1838. This result accords very nearly with that, which was found by Cavendish and Hutton.

† Davy, however, afterwards abandoned his hypothesis. See Consolation in Travel, or the Last Days of a Philosopher.

‡ Loco cit. § Loco cit. iii, p. 57 and 94.

‖ L. c. p. 172. See also Daubeny's Description of Active and Extinct Volcanos. Lond. 1826. p. 372, and v. Humboldt's Reise, etc. t. i, p. 195.

crystals of salt. He father notices the spongy lavas which contain so much iron-glance, and is of opinion that this may also be a consequence of the sublimation of chloride of iron, and its subsequent decomposition, by coming in contact with aqueous vapor and atmospheric air, while at a red heat.* And, lastly, he mentions that chloride of iron, in contact with water, becomes so exceedingly hot, that it is capable, in large quantities, of raising itself to a white heat, and that the chlorides of silicium and aluminium must be able to produce a much more extraordinary degree of heat.

It cannot be denied that there is some justness in these conclusions. But it must be remembered, on the other hand, that the premises are only taken from appearances at *Vesuvius*,† and that the occurrence of common salt and muriatic acid in the products and exhalations of volcanos, seems by no means to be general. We have already quoted Boussingault's observation, that muriatic acid is not evolved from the volcanos under the equator in the New World. The hot springs in those regions contain but little

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* We may here notice the formation of artificial crystals of oxide of iron in a potter's furnace. Poggendorff's Ann. v. xv, p. 630. Mitscherlich, who gives an account of this, finds an analogy between this formation and similar ones in volcanos. He explains it by supposing that common salt and steam both act together upon silica or siliceous combinations, and form muriatic acid, and that this comes either alone or with a small quantity of water into contact with oxide of iron, or ferriferous combinations. Thus chloride of iron is formed, which is again decomposed by the aqueous vapors, and, if the decomposition proceed slowly, the oxide of iron remains behind in large crystals.

In some volcanic eruptions, the conditions necessary for the formation of iron glance seem, indeed, to have been very frequent, whilst in others they have been entirely wanting. It is not only the lavas of *Vesuvius* and *Aci-reale* in *Sicily*, and the rents in the lava of *Stromboli*, which contain distinct crystals of iron-mica; but it is also found in the greatest abundance in *Auvergne*, (*Volvic*, *Mont d'Or*, *Puy de Dome*, etc. . . . .) On the other hand, it has never been found by Nöggerath in the volcanic masses of the *Siebengebirge*, the *Laacher See*, and the *Eifel*; it has only lately been found that some of the slags of the *Roderberg*, an extinct volcano, about two leagues distant from *Bonn*, are scantily covered with iron-glance. See Thomæ der vulkanische Roderberg, &c. Bonn. 1835. p. 22. It is worthy of notice, and speaks in favor of the probability of the above-mentioned production of iron-glance, that in the places last mentioned, the appearance of combinations of chlorine is very limited.

† The observations of Von Humboldt, Gay-Lussac, Von Buch, and Monticelli, made at different times, shew also that the exhalations of muriatic acid are very variable. They are sometimes so frequent as to surpass the exhalations of sulphurous acid, sometimes only a few traces of it are found.

common salt.* In my frequent excursions in the vicinity of the *Laacher See* and in the *Eifel*, I have never found any efflorescence of salt either on the undisturbed or fresh broken lavas, and other products of the extinct craters in those districts. On the uncovered walls of trass, in the *Brohl* valley, efflorescences are, indeed, to be found, but they contain chlorides only as very subordinate ingredients.† The lixiviation of trass, basalt, and other volcanic rocks, also gives but a trace of common salt.‡ That muriatic acid must have played a very insignificant part in the eruptions of these ancient volcanos, seems to be proved by the mineral springs which rise in their vicinity; for common salt is one of their least considerable components, indeed they frequently contain mere traces of it. This is the result of more than forty analyses of mineral springs in those regions, which I have undertaken during these last few years. But these waters would extract the chlorides from the volcanic masses through which they flow, if they existed in any considerable quantities in them, and would return impregnated with them to the surface.

From all this we do not seem to be justified in considering the chlorides as the chief agents in volcanic phenomena, although it cannot be denied that they may, in some instances, co-operate in their production.§ It has even been supposed that the beds of

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* Loco cit. p. 181. † Die vulkanischen Mineralquellen, &c. p. 243.

‡ Idem, p. 246 and 247.

§ Many volcanos have produced considerable quantities of common salt, as, for instance, *Vesurius*, *Hecla*, &c. Also sal-ammoniac is found among the volcanic sublimations of *Vesuvius* and *Etna*, and almost exclusively in some volcanos of the interior of *Asia*. Vauquelin found in a porous rock, constituting a considerable part of the *Puy de Sarcouy*. in the chain of the *Puy de Dôme*, 0.055 of muriatic acid, which is worthy of remark in connection with the frequent occurrence of iron-glance in that neighborhood. (Ann. des Mines. vi, p 98.) There are felspar crystals in the trachyte, colored sulphur-yellow by muriatic acid vapors of a former time. Common salt also forms the chief ingredient in the thermal springs of *St. Nectaire*, in the department *Puy de Dôme*. In the mineral springs of *Mont d'Or*, *Vichy*, *Chaudes-Aigues*, *Vals*, &c., on the contrary, it is in very small quantities. In the lavas of *Etna* 0 01 of muriatic acid has been found. In basalt, Kennedy found 0.01; Klaproth 0 0001; and I, 0.0085 of muriatic acid. I also found that acid in a steatitic substance in the trachyte conglomerate of the *Siebengebirge*. See "Die vulcanischen Mineralquellen," p 277. But this occurrence of muriatic acid, which may, perhaps, be found in many other volcanic productions, is far too inconsiderable for us to ascribe to it any great part in the production of volcanic phenomena. Proust tells us that, according to Garicas Fernandez, the celebrated salt mines at *Poza*, near *Burgos*, in *Old Castile*, are situated in the centre of a crater, in which the latter collected various volcanic products. Journ. de Phys. vol. lv, p. 457.

rock-salt are of volcanic origin. But this proves nothing more than that rock-salt may have been raised from the interior of the earth by volcanic power, and that the beds of salt are a consequence of volcanic action, but not conversely, that chlorides and the disengagement of muriatic acid are the cause of that phenomenon.

Now, since neither any process of oxidation, nor processes in which chlorides take an active part, are capable of affording a satisfactory explanation of volcanic phenomena, we can scarcely conceive any other powerful chemical process, which could alone give rise to them. We may, therefore, look upon the hypothesis which seeks the cause of volcanic phenomena in intense chemical action as untenable.

II. *The hypothesis which supposes the temperature of the earth gradually to increase towards the centre, to a red and white heat, explains in a satisfactory manner (according to the present state of science) volcanic phenomena as well as earthquakes.*

If the heat of the earth continually increases with the depth, the rocks must at a certain depth be in a state of fusion. But since they possess such various degrees of fusibility, the more fusible rocks must be in a liquid state, at depths in which the less fusible ones are still solid. At certain depths there must, consequently, be masses of melted rocks, enclosed in the solid rock, in the same manner as iron ores are melted and reduced in the less fusible masses of which blast furnaces or crucibles are composed. These depths must, according to the above hypothesis, be looked upon as the seat of volcanic action. The crystalline rocks are the most easy of fusion on account of their containing alkalies, which indeed are not wanting in any of them. So that, in general, the more abundantly alkaline minerals, as felspar, mica, leucite, &c., are contained in volcanic masses, the more readily will they fuse.*

Sir James Hall† has endeavored to ascertain the degree of fusibility of various lavas and other volcanic rocks. Lava from *Ve-*

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* According to Von Buch, (Abhandlungen d. Königl. Acad. d. Wissenschaften zu Berlin, 1818–1819, p. 62,) it may be taken as a general rule, that all real lavas, which flow in streams down the sides of volcanos, contain glassy felspar. *Vesuvius* being the only exception out of so many is not worth mentioning.

† Transact. of the Roy. Soc. of Edinburgh. Vol. v, &c.

*suvius* of the year 1785, melted at 18° of Wedgewood's pyrometer, lava from *Torre del Greco* not till 40°. But their fusibility varied very considerably, according as the melted lava had been cooled rapidly to a glass, or more slowly to a stony crystalline mass. Thus, for example, those two lavas, when in the form of a glass, both melted at the same degree, (18°,) whilst the lava of 1785 was less fusible than that of *Torre del Greco*, when of a stony nature.* From other appearances it may, in general, be concluded, that the fusibility of lavas is between that of silver and copper. Thus in the lava which destroyed *Torre del Greco*, some gold and a few copper coins were found unmelted; but the silver coins were melted and baked together with some copper coins.† Davy found that a copper-wire of $\frac{1}{20}$ of an inch in diameter, and a silver-wire of $\frac{1}{30}$ of an inch, thrust into the lava near its source, instantly melted.‡ A wire of copper $\frac{1}{8}$ of an inch in diameter, which I held in a stream of fused basalt, flowing out from a furnace, melted immediately. But the basalt was doubtless heated far above its fusing point. Now according to Daniel,§ silver melts at 2233° F., but copper at 2548° F.; we may therefore take a mean of 2282° F. (=1000° R.) for the melting point of lava.

Now, if we suppose the increase of temperature to continue to follow the same progression as has been discovered in accessible depths, the lava must be in a state of fusion, according to the observations near *Geneva* and in *Cornwall*, at the depth of about 113505 feet, and from those in the *Erzgebirge* at about 126829 feet below the level of the sea near *Vesuvius* or *Etna*.‖

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* Glass is well known to be acted upon in a similar manner. When converted, by being melted and slowly cooled again, into Reaumar's porcelain, it becomes less fusible.

† Thompson: Notices of an English Traveller, &c. Breislak. (Voyage dans la Camp., vol. i, p. 279,) mentions, that when bell-metal was plunged into the lava, the zinc melted out, leaving the copper behind.

‡ Ann. de Chim. et de Phys. vol. xxxviii, p. 138.

§ Journ. of Science, xxiii.

‖ According to my observations made on a cooling basalt-ball of twenty-seven inches diameter, and which I shall communicate afterwards, the increase of temperature from the surface towards the centre of the earth, seems to take place, not in an arithmetical, but in a geometrical progression. But the exponent of this progression being very little greater than 1, this progression comes very near to an arithmetical one. The depths, above calculated, being but insignificant in proportion to the diameter of the globe, no great error has been committed in supposing

If we suppose steam to be the power by which the lavas are raised from this enormous depth, and by which the volcanic bombs, rapilli, and ashes are thrown up, and according to all observations hitherto made, water in its elastic state seems to be the only means by which the lavas* and other volcanic rocks,† are so raised; it is yet a question whether its expansive force could be sufficiently raised by heat? Parrot‡ reckons that the temperature of lava, at the moment of its ejection, is five times as great as would be necessary to raise it 48000 feet by the elastic force of steam, supposing the steam to be formed in the presence of water. But from more recent inquiries on the elastic force of aqueous vapor, this calculation must undergo considerable corrections. The formula of Mayer, as altered according to the last results of the experiments at *Vienna*§ corresponds the most nearly with the elastic force of steam as actually observed, so that it may be considered as the most correct determination of its elasticity at higher temperatures. If we wish to find the pressure of the steam in

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the increase of temperature follows an arithmetical progression as far as these depths. With this exception, we can hardly hope ever to become acquainted with the true progression of the increase of the temperature to the interior. Therefore all such calculations, as the former, can but give approximations to the truth.

* Von Humboldt's Reise, t. i, p. 186. A short time before the great eruption of *Vesurius*, in the year 1805, he and Gay-Lussac observed that the watery vapors in the interior of the crater did not redden litmus. Many other naturalists have also found that the outlets of smoke of the *Peak of Teneriffe* emitted pure water only. Voy. de La Peyrouse, t. iii, p. 2. Hoffmann, in his letter to Von Buch on the geognostical structure of the *Lipari Islands*, in Poggendorff's Annal. vol. xxvi, p. 9 and 45, and in several places in his account of the volcanic island which rose in the *Mediterranean Sea*, vol. xxiv, p. 65. According to Monticelli and Covelli, the smoke which rises from the lava-streams consist almost exclusively of aqueous vapor. Loco cit. p. 27, 65. and 83. Numerous fumaroles (exhalations of aqueous vapor) rise on the island of *Ischia* out of the cracks in the lava. Forbes, in Edinb. Journ. of Science, N. S. iv, p. 326. Reinwardt, Verhandlingen van het Bataviaasch genootsthap van Kunsten en Wetenschapen, negende deel, Batavia, 1823, p. 1. Ordinaire mentions, in his "Histoire Naturelle des Volcans," a mass of melting iron having been cast to a height of 150 feet, out of a blast furnace, by some water having accidentally got into it. See D'Aubuisson, Traité de Geognosie, v. i, p. 215.

† The water contained in basalt speaks in favor of this opinion. See Klaproth's Beiträge, &c., vol. iii, p. 249, and Kennedy in Appendix to the same, p. 255. On melting basalt, and introducing a gun-barrel into the crucible, I observed a considerable evolution of aqueous vapor.

‡ Grundriss der Physik der Erde und Geologie. Riga u. Leipzig, 1815, p. 264.

§ Arzberger in the Jahrbüchern des Polytechnischen Instituts, vol. i, p. 144.

Paris inches of a column of mercury from this formula, we shall have $$\log. e = 2.8316686 + \log. (213+t) - \frac{847.3}{140+t}$$ in which $t$ is the temperature in degrees of Reaumur $= \frac{4^\circ}{9}$ F.*

It is clear that the elastic force of steam cannot surpass a certain maximum, which it reaches when its density is equal to that of water. This is the case when the elasticity of the vapor $e = 232952$ Paris inches of mercury, or nearly 8320 atmospheres, which supposes a temperature of 2786° F.†

Thus, if aqueous vapor were to reach its greatest possible elasticity, its temperature must exceed that above assumed for the melting point of lava by 504° F. The highest column of lava, which steam at its maximum elasticity is capable of supporting, is, therefore, if we suppose the specific gravity of liquid lava three times as great as that of water, 88747 feet. But a temperature of 2786° F. will, according to the observations at *Geneva* and in *Cornwall*, be met with at a depth of 139265 feet, and according to those in the *Erzgebirge*, at a depth of 155613 feet (about thirty English miles) below the level of the sea near *Vesuvius* or *Etna*.‡

Supposing, then, the values found for the maximum elasticity of steam for the corresponding temperature, and for the depth at which that temperature must exist, to be correct, it would not be possible, that a column of lava, of the whole height, from the seat of the volcanos to the surface of the earth, should be raised up. On the other hand, in the same manner as a bubble of air let into a barometer, drives the mercury into the Torricellian vacuum far above the barometric height, aqueous vapor may raise a column of lava of a height equal to its expansive force into the channels opening into the craters. Thus, then, it may happen that aqueous vapor, though far from its maximum elasticity, may yet be able to raise a column of lava equal in height to its elasticity from still greater depths to the surface of the earth. A continual alternation of columns of lava and steam in the channels may be very well conceived, the consequence of which would be an alternate

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* On steam and steam engines in the Abhandlungen der Königl. technischen Deputation für Gewerbe, part i, p. 344.

† Ibid.

‡ Supposing the mean temperature of this localtiy = 61° F.

ejection of lavas, red hot masses, and clouds of steam, just as Spallanzani,* Scrope,† and Hoffmann,‡ observed on *Stromboli*.

We have now to examine the circumstances under which water might find its way to the origin of volcanic action. The difficulties which present themselves when we suppose a direct communication between the sea and the seat of the volcanos, have already been discussed by Gay-Lussac. We shall make an attempt to solve these difficulties.

If we imagine the sea to have free access by means of fissures to the seat of the volcanos, the depth of which, according to the above calculation, may be taken at from 113505 to 126829 feet, the elastic force of steam at that depth, where $t = 2282°$ F., will be $= 5310$ atmospheres. But the hydrostatic pressure of these columns of water is only from 3547 to 3963 atmospheres. The expansive force of steam at that depth in which the temperature is 2282° F. is, therefore, greater than the hydrostatic pressure opposed to it, so that the latter cannot resist it. But since, as the temperature decreases, this expansive power diminishes more rapidly than the hydrostatic pressure, there must be a certain depth and a corresponding temperature in which they will be in equilibrium. For a constant increase of temperature of 1° F. in 51 feet, this point will be at the depth of 88044 feet below the surface of the sea, where the temperature is 1754°.5 F.;§ for, according to the above formula, if $t$ be taken equal to 1754°.5,

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* Voyag. t. ii, p. 21.

† Considerations on Volcanos, &c., p. 54. A phenomenon observed by Scrope during the night in the crater of *Stromboli* distinctly shows, that, by the force of aqueous vapor alone, the column of lava is raised. The lava once suddenly disappeared in the depth of the crater; on the contrary, innumerable little columns of steam appeared at the edges of the mouth of the crater, which arose with a hissing noise. This lasted for some minutes, when the melted mass rose again from beneath, and the phenomena pursued again its ordinary course. Spallanzani remarks very justly with a view to this, that the compressed vapors prevented from being discharged by the sinking lava which had become tenacious on the surface, will now escape laterally through the fissures in the walls of the edge of the crater, and in this case the lava cannot be elevated by them. It is not until the lava has been sufficiently heated and become again liquid, that the vapor can rise again with the lava, and that the phenomenon can be re-established.

‡ Loco cit. p. 9.—D. Curbeto also observed that a dense smoke always followed the streams of lava which were ejected on the 7th June, 1731, Von Buch in the Abhandl. d. Berliner Acad. of 1818–1819, p. 77.

§ To simplify the calculation, I have supposed the mean temperature of the surface = 32° F.

$e=77028$ inches of a column of mercury, or $\frac{77028}{28}=2751$ atmospheres, and $\frac{88044}{32}$ gives the same number. On the other hand, for a constant increase of temperature of 1° F. in 57.1 feet it advances to a depth of 105627 feet below the surface of the sea, where the corresponding temperature would be 1881°.5 F.;* for the same formula gives $e=92435$ inches of a column of mercury, or 3301 atmospheres, when $t=1881°.5$, and $\frac{105627}{32}$ gives the same value. Presupposing the correctness of the premises, these calculations shew the possibility of columns of lava of $\frac{88044}{3}=29348$ and $\frac{105627}{3}=35209$ feet being raised by the power of steam from the respective depths of 88044 and 105627 feet below the surface of the sea, whilst there is an uninterrupted communication between the sea and the volcanic focus. The difficulty mentioned by Gay-Lussac, that the water would, under its own pressure, take the gaseous form before reaching the strata, which are at white heat; without being able to raise the lavas, to cause earthquakes, and to support the volcanic phenomena; is consequently also set aside, in so far that the water cannot assume the form of gas under its own pressure before reaching those depths and their corresponding temperatures. At depths greater than 88044 or 105627 feet below the surface of the sea, if the communication with the sea remained free, a reaction would take place in the column of water. Perhaps the phenomena mentioned in Chap. xi, on Hot and Mineral Springs, vol. xxiii, of Ed. New Phil. Journal, and observed by Horner near the *Kurile Islands*, as well as the powerful stream of hot steam, observed by Hoffmann near *Vulcano*,† beneath the surface of the sea, probably at the same place where the crater of the cone formerly thrown up at this spot was situated, proceeds from a similar volcanic effervescence. In general, the rising of smoke from the sea during the eruptions of neighboring volcanos is by no means an uncommon occurrence.‡ The reflux and the internal agitation of the sea is

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* To simplify the calculation, I have supposed the mean temperature of the surface = 32° F.

† Loco cit. p. 67.

‡ D. Curbetto (Von Buch loco cit. p. 78) observed a great quantity of smoke and flames (?) accompanied with tremendous detonations, rise from the sea near *Lancerote*, during the volcanic eruption on that island. Fish and pieces of pumice were seen floating about. Several examples of this sort are cited farther on.

also a forerunner of almost all eruptions, especially of those of *Vesuvius*.

But if a reaction should take place in the column of water, yet the rising vapor would soon be so far cooled down as to become liquid again, without the expansive force of the enormous quantities of vapor formed at the volcanic focus being thereby perceptibly diminished. In addition to this, the hydraulic resistance in the narrow channels, through which the water is admitted, increases very considerably as its velocity becomes greater. But the column of water, by which the aqueous vapor is cut off from communication with the surface, acquires very great velocity in those narrow channels, from the enormously increased elastic force of the steam, by which the resistance may very easily be increased to the extent of much more than 1000 atmospheres. So that, notwithstanding that the expansive force of steam whose temperature exceeds 1754° or 1881° F., is greater than the hydrostatic pressure of the column of confining water, yet this resistance may suffice, in the manner just mentioned, to raise a column of lava, of even a greater height than we have above reckoned, to the summit of the volcano. If we may be allowed to make a comparison with an analogous phenomenon, it may be remembered that the touchhole of a cannon, or of a bore-hole in a mine, does not weaken much the action of the powder, although the proportion of the diameter of the touchhole to that of the mouth of the cannon is as 1 : 30.* If Perkins's well known observation,† that water and steam cannot be forced through narrow openings in the red-hot generator of a steam engine, is applicable to the gigantic generator, which formed the volcanic focus: this might be added to the causes already mentioned, which afford resistance in the channels through which the waters are admitted.

So long as the communication with the sea remained open, the volcano could never come to a state of rest, although the forma-

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* But even when the touchhole becomes considerably widened by frequent use, the cannon is still of service, although, indeed, its power is somewhat diminished. Yet the force with which the powder projects the ball is equal to about 2200 atmospheres, in which the loss occasioned in the absolute expansive force of the powder by the touchhole, &c., is already allowed for. Muncke in Gehlers Physikal. Wörtembuch, new edition, v. i, p. 712.

† Quarterly Journ. of Sc. July to Dec. 1827, p. 471, and Annal. de Chim. et de Phys. xxxvi, p. 435. See also Muncke in Poggendorff's Ann. vol. xiii, p. 244, and Buff in the same, vol. xxv, p. 591.

tion, or much more the access of new lava from remote places, might require a long period before actual volcanic eruptions could again take place. Of *Vesuvius* we know that the periods, when it is entirely free from evolutions of aqueous vapor, are not of long duration. On *Lancerote* some of the cones, which were erupted eighty years ago, still continue to emit steam. The cones of *Jorullo* emitted boiling hot vapors, and boiling springs rose in the neighborhood at the time when Von Humboldt visited them, that is, forty-four years after the last eruption. Burkart, on visiting *Jorullo* twenty-four years afterwards, saw scarcely any evolution of watery vapor from these cones; but vapor of the temperature of between 113° and 129° F. was still rising from fissures in the neighborhood of the principal crater.* Very hot vapor continues to the present day to issue in all directions from the sides of the rocks on *Pantellaria*, and yet there seem to have been no eruptions on this island since the commencement of the historical era.†

But it is very probable that the channels by which the water enters become obstructed from time to time. This may be effected by the lava itself, which is the more likely, as the channels may perhaps be very narrow. It may, however, also be caused by the hot steam. Indeed, Monticelli and Covelli observed, during the eruption of *Vesuvius* in October of 1821, that the fragments of lava, when no longer possessed of a great internal heat, remained separate; but that when they were themselves very hot, or traversed by the hot vapors, they united so firmly together, that they could be separated only by heavy blows with a hammer on the tenacious surface.‡ If the aqueous vapors of ordinary elasticity and temperature are able to effect

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* Aufenthalt and Reisen in Mexico in den Jahren, 1825, bis 1834 Von Burkart. Stuttgart, 1836, t. i, p. 227 and 228.

† Hoffmann, loco cit. p. 69.

‡ *Loco cit.* p. 10. It may perhaps be allowed here to mention an observation of my own, though on a somewhat limited scale. I found that the stones by which the *Kaisersquelle* at *Aix la Chapelle* is closed, and that the canals of the *Schwerdtbad* at *Burtscheid*, which consist of black marble, were converted on the inner side into a doughy mass by the continued action of the steam. But the temperature of this steam is only 133° to 167° F. There occur innumerable instances of decompositions and alterations which rocks suffer when exposed to the continued effects of heat and acid watery vapors. See among others Krug von Nidda, p. 274. Burkart, loco cit. t. i, p. 194.

this, what effect, it may be asked, may not steam of such extraordinary elasticity, and of a temperature equal or even greater than the melting point of lava, exert upon fusible rocks, solidified masses of lava, &c., which it meets with far above the volcanic focus in colder regions? Would not such steam convert the rock into melted liquid matter? It is, indeed, difficult to conceive a state of which even Papin's digestor can give us but a slight idea.

If the channels become obstructed after a considerable quantity of water has found its way to the volcanic focus, the aqueous vapor may attain its maximum elasticity, as the focus will act like a steam-boiler closed on all sides, that is to say, it will be able, according to the above calculations, to raise a column of lava of 88747 feet.

The filtration of a large quantity of water, which, although it becomes gradually heated as it descends, is prevented by its velocity from assuming the temperature of the strata through which it passes, must tend to cool the volcanic masses. But it will be cooled to a far greater extent by the considerable formation of steam. In this manner a gradual solidification of the lava will take place not only in the crater, but also in the great volcanic focus itself,* whereby the termination of the volcanic eruptions is produced.† The contraction of the walls of the volcanic focus during the reduction of their temperature causes fissures in the rocks,‡ by which the waters are admitted in other places. But in doing so, it may frequently happen that these fissures do not communicate with the channels by which the water is admitted, and that on its revival the slightest shock is sufficient to break

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* Necker, Memoires de la Société de Physique et d'Histoire Naturelle de Genève. Genève, t. ii, part i, p. 155.

† Observations made on *Vesuvius* and the *Peak of Teneriffe* shew, that the greater part of the ashes is thrown out last, so that their appearance may be considered as a sign of the approaching termination of the eruption. In proportion as the elasticity of the vapors diminishes, the substances will be thrown to a less distance, so that the black rapilli, which are the first ejected after the lava has ceased to flow, will be cast farther than the white ones. Von Humboldt's Reise, t. i, p. 245.

‡ It is well known that considerable fissures are formed in lava during its cooling, especially when it is on the surface of the earth. The streams of lava in the country surrounding the *Laacher-See*, offer many instances of this kind. Hamilton also mentions great fissures in the lava-streams of *Vesurius*. Gilbert's Annal. t. vi, p. 23. See also Necker, loco cit.

through the walls, and thus to reopen the communication.* This may even be caused by the expansion of the cooled walls of the focus by the heat communicated to them from all sides; in the same manner as a small crack in a crucible increases when exposed to a red heat.

The more the temperature of the lava is reduced by the water and the generation of the steam, the longer will be the time required for the refusion of the solidified lava. In this manner a long period may elapse, as the lava is so very bad a conductor of heat.† The repose and activity of a volcano are, therefore, the alternate solidification and liquefaction of the lava, and the interruption and renewal of the supply of water to the volcanic focus.‡ If the store of lava in the volcanic focus should at first become exhausted by repeated discharges, the volcano is entirely reduced

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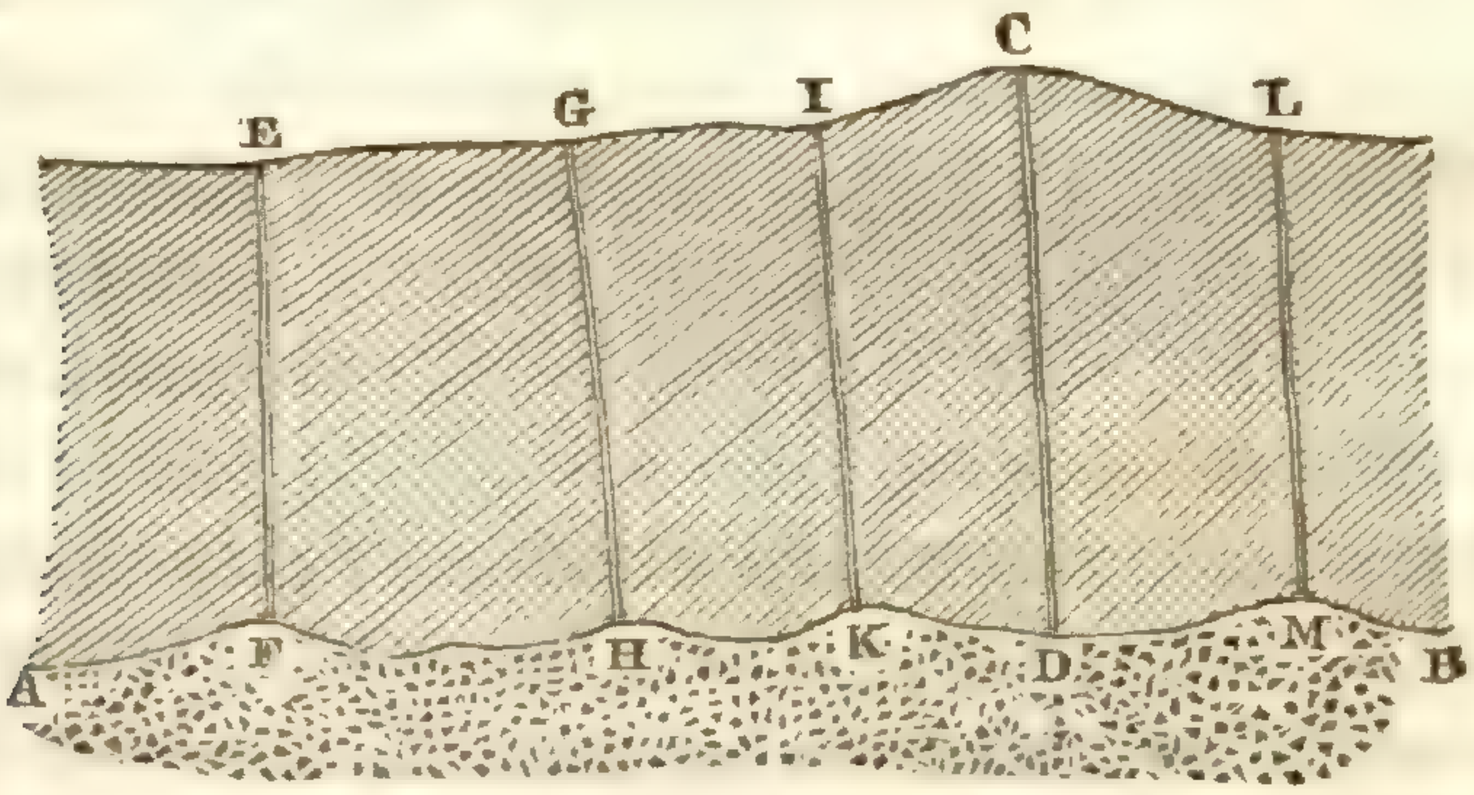
* We may here notice the well-known phenomenon, that among the ejected masses from a volcano, pieces of rock occur, which neither belong to the substances composing the edge of the volcanic cone, nor to those found in the vicinity, and therefore must be derived from masses concealed very deep under the volcano. *Vesuvius* particularly, furnishes remarkable instances of this kind. Such ejected masses, however, are now found much more rarely than formerly on this or other volcanos, from which it seems to follow, that the channels of the ejections have been by degrees widened.

† Monticelli and Covelli, loco cit. p. 15 and 39.

‡ Experiments hitherto made shew, that long spaces of time are requisite to produce the strongest effects, viz., the elevation of lava to the greatest height. Von Humboldt (Reise, &c., t. i, p. 261,) calls our attention to the circumstance, that long intervals of quiescence seem to characterize the very high volcano. The smallest of all, *Stromboli*, is nearly always in activity. The eruptions of *Vesuvius* are less frequent, although they are still more so than those of *Etna* and the *Peak of Tenerиffe*. During the quiescence of the latter, from 1706 to 1798, sixteen eruptions of the former took place. From the colossal summits of the *Andes*, *Cotopari* and *Tunguruhua*, an eruption is observed scarcely once in a century. We may venture to state, that the frequency of the eruptions of active volcanos is inversely as their height and mass. After these general remarks, we may mention the circumstance that large lava streams, namely, such as issue from *Etna* and *Vesuvius*, never flow from the crater itself, and that the quantity of the melted matters is commonly inversely as the height of the fissures from which the lava issues. But a lateral eruption of these two last-mentioned volcanos always terminates by an emission of the ashes from the crater, that is, from the summit of the mountain itself. This phenomenon has not been seen on the *Peak of Teneriffe* these last hundred years. The crater was most inactive during the eruption in the year 1798. Its basis did not sink, whilst the greater or less depth of the crater of *Vesuvius*, according to the acute remark of Von Buch, is an almost infallible sign of an impending fresh eruption. Von Humboldt, p. 268. All this shews that the conditions requisite for producing the greatest effect, viz., for producing the highest degree of the increased elasticity of the watery vapors, are not always present.

to a state of rest, or at least until it receives a fresh supply of lava from a distance. If the afflux of water be not interrupted, the exhalations of vapor may still continue, of which we have already mentioned several instances.

We may next consider how lava may be elevated from the depth of a volcanic focus. The hypothesis, which ascribes volcanic phenomena to the central heat, supposes that melted matters exist at a certain depth. In adopting this opinion, we need not assume that lava is produced by the melting of solid rocks, but on the contrary, that melted matters have existed since the creation of the world.* In the annexed diagram AB represents the




boundary between the solid crust of the earth and the melted matters in the interior of the earth; CD represents a wide rent, exhibiting a communication from the surface to the melted matters; EF, GH, IK, LM, &c., are narrow rents conducting water from the sea or subterranean collection of water to the heated interior;† and F, H, K, M, may be caverns in the solid crust, formed during the consolidation of the originally fluid matters of a former period. Under these circumstances it may easily be conceived, that water penetrating into the above mentioned rents and caverns is converted into steam, which, by pressing on the melted matters, causes them to rise through the rent CD. If the lower opening in the wide rent at D be on the same level as the whole boundary between the solid rocks and the melted matters,

*On this supposition, we assume that no basalt has been produced by the repeated melting of any known rock. Leonhard's Basalt Gebilde, &c. Stuttgart, 1832, t. i, p. 263.

† Water will naturally also penetrate into the wide rent, but, inasmuch as it is not able to fill up the rent, it cannot confine the steam generated beneath, and the latter will therefore escape.

small quantities of these only will be raised upwards, for the surface of the melted matters will soon sink below the opening of the rent at D, and steam will rise. Thus the elevation of a column of lava to a considerable height by a column of steam will take place. But if the lower opening of the rent CD descends more or less below the surface of the melted matters, considerable quantities of these will rise into it before this surface sinks below the opening. The same may take place if between the opening of the rent CD and the other rents, (those down which water flows from the surface,) ridges of solid rock reach downwards from the solid crust into the fluid mass.

Such ridges may be viewed as occasioned by gradual solidification of the fluid mass from above downwards, for it is well known that melted matters, if they crystallize by cooling, exhibit on their under surface considerable inequalities; and the consolidation of the melted matters in the interior of the earth is assuredly produced by crystallization.

There is another circumstance which may cause a continuation of the rent CD into the melted matters. After the rising of the lava and steam in this rent, the walls of it are cooled by the formation of steam, and by the atmospheric air having a ready access to the empty channel. Therefore these walls may gradually increase by the solidifying of the melted matters; nay, the rent may be entirely solidified and obstructed, so that it can only now be re-opened by the force of steam previous to a new eruption taking place. If even immense quantities of lava are ejected by the steam, yet the level of the melted matters in the interior may be but slightly changed, for in the same manner, as all seas on the surface of the earth communicate together, so the melted matter in the interior does the same. However, more or less time may elapse, before the melted matter which has sunk at one place in consequence of ejection, can regain its former level by the afflux of other melted matters from a distance. Therefore the repose and activity of a volcano, besides depending on the interruption and renewal of the supply of water to the volcanic focus, may also proceed from the alternate obstruction and re-opening of the lava channel by the melted matters. In the latter case, in the state of rest, exhalations of steam will take place, inasmuch as water penetrates continually to the volcanic focus.

But if the afflux of water be interrupted by an obstruction of the water-ducts, and if none of the above-mentioned causes be capable of restoring the communication; or if, during the repose of the volcano, the lava-ducts become so obstructed by consolidation, that the steam cannot force its way through them, a volcano may reach a state of perpetual repose. Such causes may have effected the extinction of the volcanic activity of the numerous extinct volcanos distributed throughout the globe. If this took place at a former period, when the thickness of the crust of the earth was still increasing considerably, in consequence of the gradual cooling of the earth, and as this process is still going on, there is no probability that such extinct volcanos will at any time become again active.

If volcanos, for instance *Etna*, are considerably elevated above the surface of the earth, it commonly happens that the walls of the lava-channels cannot resist the pressure of the melted matter in their interior. In this case rents are formed from which the lava issues. Such rents are always seen in the direction of the axis of the volcanic cone,* and their extent is often very considerable. A rent of this description produced by one of the most violent eruptions of *Etna*, viz. that of the 11th May, 1669, was $2\frac{1}{2}$ German miles in length, and occupied almost one-third of its height. Scrope† saw distinct traces of it near *Nicolosi* so late as the year 1819. Even the rent formed during the eruption in 1794, on the declivity of *Vesuvius*, towards *Torre del Greco*, was, according to Von Buch 3000 feet in length, and according to Breislak, 237 feet in breadth at its upper edge.

Other volcanos afford instances of the formation of rents and hills. Thus, during the most violent eruption of *Scaptar Jokul* on *Iceland*, in 1783, a rent eight English miles in length was formed in a plain at the foot of the mountain. Three craters, from which immense quantities of lava flowed out, rose in the direction of the rent, and afterwards a fourth appeared below the sea in the same direction, and at a distance of thirty miles, the eruption of which formed an island, which afterwards disappeared again.‡ Similar phenomena took place in the same year in the island of *Java*. And Von Buch§ informs us, that in the island of

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* Von Buch's Beobachtungen, &c., t. ii, p. 137.
† Considerations, p. 158. ‡ Ibid, p. 154.
§ Leonhard's Taschenbuch, 1824, t. ii, p. 439.

*Lancerote*, during the eruption in the year 1730, a rent was formed above two German miles in length, on which about twelve conical hills rose, whose summits were from 600 to 800 feet in height.

In like manner basaltic cones, (also porphyritic and granitic hills,) are often seen, which are situated in a line, and of which two or more are connected by rents, which are filled up by basalt. Remarkable phenomena of this kind are seen near *Murol* in *Auvergne.**

It seems surprising that the same kinds of lava are not always ejected from volcanos. Von Buch† distinguished on *Vesuvius* alone, eighteen distinct principal kinds of lava; and old and new lavas of *Etna* also differ in their characters. The lavas of neighboring volcanos are often very different from each other. In like manner, unstratified rocks of very different natures are often met with close to each other.‡ The *Siebengebirge*, near *Bonn*, offer remarkable instances of this kind. There, trachytes, trachyte tuffs, basalts, and basalt tuffs, are met with close to each other. Basalt dykes traverse the trachyte and the trachyte tuffs, and volcanic scoriæ occur on the *Roderberg*, opposite to the *Siebengebirge*, on the left bank of the *Rhine*. However different all these rocks are, yet they seem to lead to the conclusion that their origin has been from the very same materials; for, notwithstanding this difference in their nature, it would be easy to form in the *Siebengebirge* a gradation from a white trachyte to a compact black basalt.§ On the other hand, there is every reason to suppose that the nature of melted matters in the interior is different in different places. If, therefore, after the ejection of melted matters existing in a particular spot, new eruptions will take place only when such matters flow from remote places towards this spot, we can hence easily conceive how different lavas may be ejected at different times. In the *Siebengebirge*, as well as in other places where unstratified or volcanic rocks occur, many in-

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* Leonhard's Basalt Gebilde, t. i, p. 408. † Beobachtungen, &c. t. ii, p. 174.

‡ The lavas of *Vesuvius*, of the *Solfatara*, of *Ischia*, and of *Etna*, are quite different in their nature.

§ See Leonard Horner, on the Geology of the Environs of Bonn, in the Transactions of the Geological Society, vol. iv, 2d Ser. p. 438. Von Buch states that in several places in the neighborhood of *Clermont* and *Puy de Dome*, a transition from granite into trachyte may be traced, and thus to have the gradation extended from granite to basalt.

stances are exhibited, which indicate that these rocks are of very different ages.*

If the activity of a volcano ceases, but the channels by which the waters enter remain open, the volcanic action may be replaced by hot springs.† In this case it is easy to conceive that the meteoric waters, continually sinking into the hot interior, would there assume the surrounding high temperature, and rise again to the surface with a temperature, diminished proportionally to the decrease of pressure, either through the former lava-channels, or other fissures more recently opened.‡ But if at that depth, the hydrostatic pressure be greater than the elastic force, which the water has there acquired, no steam will be generated in the whole course of the spring; but, in the contrary case, from the lowest point up to the point where the elastic force becomes greater than the hydrostatic pressure, the water will escape in the form of a vapor. However high the temperature of the water may be at the lowest point of its course, whether in the liquid or in the gaseous state, yet, when it reaches the surface, it cannot exceed the boiling point. The reason of springs but seldom attaining even this maximum, may be either the loss of heat communicated to the superior strata of the earth, or that they meet with streams of gas, (carbonic acid, or sulphuretted hydrogen,) which, even if possessed of very high temperature, will cause a depression of their temperature, as is proved by experiments cited in Chap. II, of Memoir on Springs, p. 336, vol. xx, Ed. Phil. Journ.§ The production of hot springs, according to the last species of volcanic

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* L. Horner, l. c. p. 467.

† Von Buch, loco cit. p. 65. A remark of some interest, in tracing the connection of hot springs with volcanic phenomena, is made by Burkart, loco cit. vol. i, p. 316, viz. that the boiling hot springs in the valley of *Pate* are situated on a line, running from east to west, parallel to the general line, of volcanos in *Mexico*.

‡ Von Humboldt is also of opinion, Reise, &c. t. i, p. 187 and 188, that the vapor which rises from the "*Narices del Pico*" as they are called, and from the rents in the crater of *Teneriffe*, is nothing but atmospherical water which has penetrated by infiltration.

§ According to M. Arago, the hottest spring in *Europe* unconnected with modern volcanic action is that of *Chaudesaigues* in *Auvergne*, whose temperature he quotes at 176° Fah. Annuaire du Bureau des Longitudes, 1836. The next hottest to this seems to be *Thuez*, in the *Pyrenees*, whose temperature is, according to Professor Forbes, 171°.5 Fah. Phil. Trans. t. ii. p. 603. for 1826 Forbes believes, p. 610, the baths of *Nero*, near *Naples*, the hottest spring on the continent of *Europe*, which is connected with modern volcanic action, the temperature being 182°.2 F.

action, may, however, be thus imagined; that the water which descends to the volcanic focus is there converted into steam, which, rising through fissures into higher regions, meets with atmospheric waters which it warms, and with them returns to the surface.* The course of hot springs produced in this manner can, therefore, occur only at inconsiderable depths below the surface. Lastly, it may happen that the lava last raised did not escape from the crater or its lateral openings, but became solid on its way onwards, and thus stopped up the channels. If, in this case, water should descend through rents into this still extremely hot lava, hot springs would also thus be produced, supposing a communication between these and other rents which lead to the surface at a lower level; but these springs will decrease in temperature by degrees as the lava gradually cools, till they reach that degree which naturally belongs to the place where the lava is situated. However, we have already proved by experiments formerly mentioned, and calculations founded upon them, that, if such masses of heated lava be of considerable extent, a very long period may elapse before the decrease in the temperature of the springs will be even perceptible.† On the other hand, there are examples of a very rapid decrease in the temperature of hot springs in the neighborhood of volcanos recently become extinct. Thus, the temperature of the hot springs on *Jorullo* decreased 40°.5 F. in twenty four years, between the visits of Von Humboldt and Burkart.‡ The temperature of the mixture of gases which issues from the rents in the Pass of *Quindiu*, near the *Moral*, in the *Quebrada del Azufral*, decreased from 1801 to 1827, according to the observations of Von Humboldt and Boussingault, from 118° to 66°.4.§ If, instead of this gas, a mineral spring had flowed at this place, it would, doubtless, have suffered a similar diminution of temperature. Boussingault mentions, on the other hand, that, in a period of twenty-three years, the temperature of

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* Perhaps the numerous hot mineral springs which rise at the foot of the still smoking mass of rocks on *Pantellaria*, as well as the numerous hot sulphureous springs in the vicinity of *Sciacca*, in *Sicily*, have a similar origin. Hoffmann, l. c.

† Die vulkanischen Mineralquellen, &c. p. 150.—I have calculated, that, under the circumstances there mentioned, a mass of melting basalt, equal in size to one-third of the *Donnersberg*, near *Milleschau*, in *Bohemia*, would be sufficient to have heated all the water which has issued from the whole number of springs at *Carlsbad* since the time of Adam.

‡ Burkart, loco cit. t. i, p. 226.

§ Poggendorff's Annal. t. xviii, p. 353.

the hot springs of *Mariana* and *Las Trincheras* rose several degrees. According to the observations of Hamilton, Della Torre, Abbé Soulavie, Von Humboldt, and Forbes, the hot spring named *La Pisciarella*, which rises near *Naples*, from the exterior of the cone of the Solfatara, is subject to extraordinary alternations in its temperature, from 101° F. to 199.°4 F.* But even in very short periods striking differences are sometimes found. Thus Forster† asserts, that in the neighborhood of *Tanna*, a volcano on one of the *New Hebrides*, the hot springs vary several degrees in temperature from one day to the other.

There is not, perhaps, a more striking example of intimate connection existing between volcanic phenomena and hot springs than in Iceland. As the volcanic eruptions are there confined to the district of the trachyte formation, so also are the principal mineral springs only found in this formation;‡ from which it seems natural to infer, that it is one and the same process acting in both cases, but in a different manner.§

The hot springs in this volcanic island confirm Krug Von Nidda's system of classing thermal springs—namely, 1. *such as are constantly bubbling and boiling up—permanent thermals*; 2. *those in which this ebullition only takes place at particular periods, and which are perfectly tranquil during the remaining time—intermitting thermals*; *and*, 3. *those whose surface is always undisturbed, and in which no bubbling or boiling ever takes place.* The springs of the first class always have a temperature at the surface equal to that of boiling water under the usual atmospheric pressure. Those of the second class only reach the boiling point during their temporary ebullition, and lose considerably in temperature during their period of rest. The springs of the third class never reach the boiling point of water.

The most famous of the intermittent springs is the *Great Geyser*. At the time when Krug Von Nidda visited it, it presented two different kinds of eruption. The smaller ones were repeated regularly every two hours; and the water was thrown only from fifteen to twenty feet high. The greater ones succeeded each

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* Forbes, loco cit. p. 611. † Journ. de Phys. 1779, p. 434.

‡ All the hot springs of *Mexico* also rise out of trachyte and dolerite rocks. Burkart, p. 363.

§ Krug Von Nidda on the mineral springs of *Iceland*, p. 272, in Karsten's Archiv. t. ix, p. 247, and in Jameson's Phil. Jour. vol. xxii, p. 90 and 220.

other at intervals of from twenty-four to thirty hours; in these cases, the masses of steam ascended to the clouds, and the water spouted to a height of ninety feet. For two hours after, one of the smaller eruptions, during which time there were no traces of action, and only thin clouds of steam were formed at the surface, the temperature of the water was 194° F., which was reduced still lower by the evaporation. After a dull rumbling noise within, the water suddenly began to boil up again, the basin was filled till it flowed over, immense bubbles of steam burst from the funnel-shaped opening, and projected the water to a height of about twenty feet. Immediately after the eruption, when tranquillity was completely restored, the water was at the boiling point, but its temperature soon fell below that degree.

The *Strokr*, the eruptions of which almost exceed in grandeur those of the *Great Geyser*, has this peculiarity, that it is at the same time a permanent and an intermittent thermal spring. It shows itself to be permanent by its incessant ebullition, and intermittent by the tremendous eruptions which seem to be repeated at intervals of from two to three days.

No doubt can be entertained respecting the nature of the agent by which the waters of the *Geyser*, the *Strokr*, and other less considerable springs, are thrown to such an immense height. It is, as in volcanos, a gaseous body, principally aqueous vapor. We may, therefore, very fairly agree with Krug Von Nidda, and consider volcanos in the same light as intermittent springs, with this difference only, that instead of water they throw out melted matters.

He takes it for granted that these hot springs derive their temperature from aqueous vapors rising from below. When these vapors are able to rise freely in a continued column, the water at the different depths must have a constant temperature, equal to that at which water would boil under the pressure existing at the respective depths. Hence the constant ebullition of the permanent springs, and their boiling heat. If, on the other hand, the vapors be prevented, by the complicated windings of its channels, from rising to the surface; if, for example, they be arrested in caverns, the temperature in the upper layers of water must necessarily sink, because a large quantity of it is lost by evaporation at the surface, which cannot be replaced from below. And any circulation of the layers of water at different tempera-

tures, by reason of their unequal specific gravities, seems to be very much interrupted by the narrowness and sinuosity of the passage. The intermitting springs of *Iceland* are probably caused by the existence of caverns, in which the vapor is retained by the pressure of the column of water in the channel which leads to the surface. Here this vapor collects, and presses the water in the cavern downwards until its elastic force becomes sufficiently great to effect a passage through the column of water which confines it. The violent escape of the vapor causes the thunder-like subterranean sound, and the trembling of the earth, which precede each eruption. The vapors do not appear at the surface till they have heated the water to their own temperature. When so much vapor has escaped that the expansive force of that which remains has become less than the pressure of the confining column of water, tranquillity is restored, and this lasts until such a quantity of vapor is again collected as to produce a fresh eruption. The spouting of the spring is, therefore, repeated at intervals, depending upon the capacity of the cavern, the height of the column of water, and the heat generated below.*

The two distinct classes of eruption in the *Geyser*, which we have already mentioned, seem to be attributable to two different cavities. A smaller cavity fills quicker, and, therefore, empties itself more frequently; a larger one fills slower, empties itself seldomer, but with greater violence. But the playing of the *Geyser*, the *Strokr*, and some others, is subject to very great va-

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* The eruptions of the *Geyser* and the *Strokr*, as observed by Krug Von Nidda, agree exactly with his explanation of the action of the intermitting springs of *Iceland*. A thick column of smoke suddenly burst out of the latter, and rose to the clouds. The water was hurled with terrific violence out of the crater, and mixed like a fine mist with the rest of the column to a considerable height. From time to time, thin streams of water were seen shooting in a vertical or oblique direction through the column of smoke, sometimes rising to a height of a hundred feet and upwards. Large stones, which had been previously thrown in, were flung almost out of sight, and many so perfectly vertically that they fell down again into the crater, and were again thrown up into the air, like a juggler's ball. The whole of the water was thrown out at the beginning; and afterwards, the column which ascended from the opening, was composed only of steam, which rushed out with a whistling and hissing noise, and rose with incredible velocity into the clouds. It continued for three quarters of an hour in this state of activity. It then again became quiescent, except that the water, deep in the tube, continued, as usual, to boil violently.

riations. Channels may become stopped by the incrusting property of the water. During the frequent shocks which accompany the greater eruptions, some cavities may fall in, and be choked up, and new ones formed. The greatest changes, however, are caused by the earthquakes, which from time to time visit the island. Thus, during the earthquake of 1789, the most important spring in the country, next to the *Geyser*, disappeared, and at present only steam is evolved from its mouth, while the *Strokr*, which before this was but an inconsiderable spring, increased to such an extent, that it is now considered to rival the *Geyser* in importance. It may be observed, that the eruptions of the *Strokr* have no connection whatever with those of the *Great Geyser*. During the long eruption of the former, the latter remained quiet, and *vice versa*. In general, each of these numerous hot springs, which are here crowded together in a very small compass, seems to be totally independent of each other. This might also be inferred from the striking difference in their levels.

It seems probable from the situation of the celebrated hot springs of *Iceland*, (of which more than fifty may be counted in a space of a few acres, at the foot of a rock about 300 feet high, which leans against a chain of higher rocks ;) from the numerous fissures in these rocks, which are composed of alternate layers of tuffas, of slag-streams, and slag-conglomerates, as well as from the fact, that the springs are confined exclusively to the lower region, which extends along the foot of the hill, whilst on its sides and summit are found only gaseous exhalations (aqueous vapor and sulphureted hydrogen gas ;) that these springs are supplied from the meteoric waters of the neighboring hills, and that, being originally cold, they are indebted for their high temperature solely to the hot vapors which they receive from below. The hot springs in *Iceland* seem, therefore, to be produced in the manner described at page 253.

Lastly, If the permanent obstruction of the lava and the water channels has taken place, of course no hot springs can exist, or at least they can only flow during the cooling of the lava last ejected and solidified. This seems to have been the case in the volcanic district of the *Siebengebirge*, the *Laacher See*, and the *Eifel*, as in these places no hot springs, with the exception of the baths of *Bertrich*, are to be met with ; although in the two

latter districts, the number of thermal springs whose temperature exceeds that of the soil at the most by a few degrees, are enormous, and considerable exhalations of carbonic gas give evidence of former galvanic action. It may, however, be conjectured, with some probability, that in the vicinity of the *Laacher See*, and in the *Eifel*, springs may have existed, whose duration depended on the cooling of the masses of lava. Similar circumstances seem to have occurred in *Auvergne* and *Vivarais*, although the hot springs, which are not uncommon in those countries, show that many of the former volcanic channels are still unobstructed.

The examination of deposits obviously formed from springs which existed at a former time, may often present an indication of their temperature. Thus, on the volcanic tongue of land, called the *Sneefield-Syssel*, in *Iceland*, we find none of the hot mineral springs which are so numerous in other parts of the island, and which are distinguished by their holding silica in solution, and exhaling sulphureted hydrogen gas. But, in former times they existed here, for in many places we find siliceous incrustations in the form of tuffas and sinters. One cold spring, which is now flowing, has certainly taken the place of a hot siliceous spring, for its present deposits are only calcareous, and quite distinct from the older incrustations.* The circumstance that arragonite is deposited from hot springs, calcareous spar, on the other hand, from cold ones, gives us also an indication of this kind. Since G. Rose† pointed out that the former is only deposited from a hot solution of carbonate of lime, the occurrence of arragonite in any deposit, leads us to infer with certainty, that these deposits owe their origin to a hot spring. If, on the contrary, we find calcareous spar in any deposit, we may infer with equal certainty, that it was produced by a cold spring.‡

If the melted nucleus of the earth be the common seat of the volcanic activity of the whole earth, subterranean communica-

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* K. v. Nidda, loco cit. p. 282. † Poggendorff's Annal. t. xl. p. 353.

‡ The following remark may not be entirely superfluous, viz. according to G. Rose, arragonite is formed in a higher temperature only in the moist way, but calcareous spar is formed in the dry way. Thus carbonate of lime crystallizes from a state of fusion under strong pressure only in the form of calcareous spar. Arragonite, exposed to a slight red heat, is easily converted into calcareous spar.

tions subsist between all volcanos. The existence of such communications cannot be doubted. Immediately after the earthquake which overthrew *Caraccas*, there followed the great eruption of the volcano of *St. Vincent*, and the earth no longer trembled at *Venezuela.* When the dense, black column of smoke, which, in the year of 1797, had issued for several months from the volcano near that city, disappeared, the cities of *Riobamba*, *Hambato*, and *Tacunga*, 280 English miles distant, were at the same hour destroyed by a violent shock.* Other instances of this kind will be mentioned afterwards.

Andrea Lorenzo Curbeto's description of the great volcanic eruption in the island of *Lancerote*, for which we are indebted to Von Buch,† also shows how, for six years, from 1730 to 1736, the gaseous fluids in the interior found new vents in all directions, sometimes here and sometimes there, and yet were not capable of preserving a single one permanently open. Sometimes two or three openings were formed at once, with a tremendous crash, accompanied with flames,(?) which alarmed the whole island. At one time, three apertures united suddenly into one very high cone; lava flowed out below and reached the sea. If, says that acute geologist, the unhappy *Lancerote* had, like *Teneriffe*, possessed a volcano, perhaps not one of those numerous cones would have been thrown up, and probably not a single village would have been destroyed.‡ He thinks it highly probable that this eruption took place entirely from one great rent.

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* Von Humboldt Reise, t. 1. p. 498. † Loco cit.

‡ Von Buch supposes that only the gaseous matters, but not solid substances, viz. lavas, slags, lapilli, and ashes, proceed from the focus of the volcanic phenomena. He observes that these masses always show themselves to be of a nature corresponding to the rocks out of which they are ejected.

We must not forget that Von Buch was at that time still attached to Davy's hypothesis. which ascribes volcanic phenomena to the combustion of the metals of the alkalies and earths, and which does not require us to suppose the origin of volcanic action to lie at any great depth. It is indeed, very different, according to the hypothesis which we are endeavoring to defend. In this, the seat of the volcanic actions is supposed to be identical with the place where the elastic forces producing them act. The connection between the lavas, and the slags, lapilli, and ashes resulting from them, and the rocks at the surface, would only then show that the same material which composed the rocks, raised at a former period, and now spread over the surface, has also served for the production of the more recent volcanic formations. But it still remains to be taken into consideration, that aqueous vapor, generated in the lowest point of the volcanic focus, possessing its maximum of elasticity, and heated to the melting point of lava, or above it, is capable, as we have already said, without the assistance of any other power, of converting fusible rocks into a state of hydro-igneous fusion.

During the violent eruption in the low country of *Skaptar Jokul* in *Iceland*, in 1783, which suddenly brought up the most enormous masses to the surface, the lava burst forth at three different points, more than two geographical miles distant from one another, and spread over a surface in the plain,* which is supposed to equal in extent sixty geographical square miles. This mass is so considerable as to surpass in magnitude that of *Mont Blanc.*† Under almost the whole of *Iceland*, there is a volcanic furnace, which communicates by many apertures with the surface. The masses of melted matter, therefore, seek an outlet at various points, and many places are mentioned, at which the lava has only been ejected once within historical times. The volcanic phenomena are not confined to the island alone, they also break through in the neighboring sea. In January, 1783, such an irruption took place in the sea, eight geographical miles from *Cape Reikianes*, several islands were raised, and great quantities of pumice and light slags were floated on the coast. In June, the whole island was shaken by earthquakes. The submarine eruption discontinued, and at a distance of fifty geographical miles, the grand eruption of *Skaptar Jokul* commenced. On the 13th June, 1830, a similar submarine eruption was repeated.‡

The immense masses of lava ejected from a single volcano, and the enormous extent in which volcanic actions are felt at the same time, scarcely leave room to doubt that every active volcano is in immediate communication with the whole melted matter in the interior. In this manner alone can it be conceived, how, for instance, the masses ejected at different times from *Vesuvius* vastly exceed the whole bulk of the mountain,§ while the latter seems upon the whole to undergo no diminution, for

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* See Om Tordbranden paa Island i Aaret 1783, ved Student Soemund Magnussen. Kort beskrivelse over den eye Vulkans, Ildsprudning i Vester Sköptefells Syssel paa Island i Aaret 1783 of Magnus Stephen sen. Kiöbenhavn 1785. Sir G. Makenzie's Travels in Iceland. Ganlieb's Island, 1819, p. 64. Th. Gliemann geogr. Beschreibung von Island, 1824, p. 107. Pennant le Nord de Globe, t. i.

† Barghaus Almanac for 1838, p. 75.

‡ Journ. de Géologie, t. i.

§ This was remarked even by the ancients; and Seneca, Letter 79, after stating the difficulty, solves it by remarking, that the fire of the volcano, "in ipso monte non alimentum habet, sed viam."—Daubeny on Volcanos, p. 155.

the falling in of its cone at one period, appears to be balanced by the accumulation of ashes at another.

If a rent, reaching from the surface to the melted matters in the interior, be of great length, but not open throughout its whole extent, the first eruption will take place where there is the least resistance.

If this channel become obstructed, the volcanic fire will seek another vent.* Violent concussions may open new fissures† and close old ones, by which frequent changes may be produced in the channels of the lava and water. Fissures obstructed by lava are closed so firmly as to be incapable of being re-opened; new ones, therefore, are formed. Thus it is, at least, if a volcano produce eruptions from its sides. If it happen that a wide and lasting vent be formed, all partial workings in the neighborhood will cease. A similar combination, although on a somewhat limited scale, is presented by groups of mineral springs, especially of hot springs. In such groups, new channels are seen to open, new springs to rise, and old ones to close. The only difference is, that, as these changes are not accompanied with any violent action, as is the case with volcanos, they require a greater length of time for their accomplishment.

We have, in the preceding inquiries, as yet only supposed the admission of water from the sea. But this does not seem always to be the case, even in volcanos situated near the sea. According to Hamilton,‡ the water of the springs and wells of *Torre del Greco* diminished so much a few days before the great eruption of *Vesuvius*, on the 15th June, 1794, that the corn mills at the principal spring were nearly stopped, and it was daily necessary to lengthen the ropes in the wells, in order to reach the water. Some wells dried quite up, and on the morning of the 12th June, at *Resina*, a subterranean rumbling noise was heard after a heavy rain. Monticelli and Covelli§ relate that, before

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* Thus the interior of the crater of the *Peak* of *Teneriffe*, shows it to be a volcano, which for thousands of years has thrown out fire only from its sides. V. Humboldt, Reise, t. i. p. 195.

† According to the inhabitants of *New Andalusia*, the soil in various districts in their province has become more and more arid, in consequence of the frequent earthquakes with which they are visited from time to time.—V. Humboldt, Reise, t. ii. p. 21.

‡ Phil. Trans. for 1795, p. 79.

§ Loco cit. pp. 12 and 63. See also Monticelli, in Leonard's Taschenbuch für die gesammte Mineralogie, vol. xiv, p. 87.

the great eruption of this volcano in 1822, at the beginning of January, the springs at *Resina*, *St. Jorio*, and particularly in the places in the immediate vicinity of *Vesuvius*, diminished perceptibly.* Monticelli observed similar phenomena before the eruption in 1813, and he thinks that, in general, they are a sure sign of one. It is hardly to be doubted that rents were opened by the earthquakes, through which the water descended to greater depths, accumulating, perhaps, in great caverns, and from thence found its way to the source of the volcanic action.

We find considerable accumulations of water in all mountains traversed by numerous fissures. We will only now mention the western declivity of the *Teutoburger Wald*, in which such considerable rivers have their source; the *Jura* mountains; and the *Gemmi*.† The volcanic inundations, of which Von Humboldt gives such extraordinary examples,‡ are an additional evidence of the existence of such great subterranean accumulations of water, in the vicinity of volcanos. Lastly, we have, further, examples of volcanos coming into action after violent storms of rain; for instance, the *Mer-Api*, in *Java*.§ In the *Andes* of *Quito*, the Indians imagine they have observed, that the quanity of percolating snow-water increases the activity of volcanos.‖ Can it, then, any longer be doubted, that the proximity of the ocean is by no

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* The same was observed twenty three days before the earthquake in *Calabria*; and also in the *Peak of Teneriffe*, in 1706. Von Humboldt, Relat. Hist. t. i. p. 393. In *Iceland*, this phenomenon was observed before the terrible eruption of *Skaptar Jokul*, in 1784. In general, in volcanic districts, the porous and much fissured rocks swallow up the rain-water, and carry it down to very great depths. Von Humboldt gives this as the cause of the extreme aridity which reigns in most of the *Canary Islands*, notwithstanding the height of the mountains, and the mass of clouds which travellers always see collected over this Archipelago. Reise, t. i. p. 173.

† Von Humboldt (Reise, t. iii, p. 229) mentions several rivers which lose themselves in the gneiss rocks. When these gneiss mountains were upraised, considerable caverns may have been formed, which were afterwards filled with water.

‡ Annal. de Chim et de Phys. t. xxvii, p. 128. This circumstance, however, must be considered, that the strong heat over the active volcano dilates the atmosphere, and produces a rising stream of air. The consequence of that is an influx of air from all sides. But this air is accompanied with moisture, which, rising with it, is condensed in the higher regions of the atmosphere, and falls down in showers. Therefore, an active volcano affords not only water, which immediately issues from its interior, but it also deprives all the environs of water. Du Carta sur les inondat. Volcaniques. Journ. de Physique, t. xx, p. 103.

§ Memoir of the Conquest of Java. London, 1815, p. 40

‖ Von Humboldt's Reise, t. i, p. 263.

means a necessary condition in the production of volcanic phenomena? But all that has been said respecting the channels by which the sea-water is admitted to the volcanic focus, holds equally good with respect to those admitting springs or rain-water; only with this difference, that, in the more lofty volcanos of *America*, the volcanic focus may be imagined much higher, and yet columns of water of considerable pressure will not be wanting, provided those accumulations of water be situated at a great height in the mountains.

The same power by which masses of lava are forced up, sometimes so as to reach the surface and flow over it, or in other cases becoming solidified in their channels, will also raise whole mountains. These elevations may take place through rents of more or less considerable width; and partly form dykes, or mountains of some magnitude; or raise up or break through the upper strata of the earth. Thus Von Buch* informs us that on the island of *Lancerote*, during an eruption in 1730, a rent was formed above two German miles in length, on which about twelve conical hills had risen, whose summits were from 600 to 800 feet in height. In like manner basaltic cones (also even porphyritic and granitic hills) are situated in a line, and of which two or more are connected by rents, which are filled up by basalt. Remarkable phenomena of the kind are seen near *Mural* in *Auvergne*.†

We have abundance of proofs of the rising of masses of melted or at least semifluid matter,‡ out of the interior of the earth, in the filling up of dykes with compact crystalline rocks, in all of which, as in the rocks of undoubted volcanic origin, felspar forms a necessary and principal ingredient.§ We find these rocks in contact with all the stratified and superficial formations, even with those which are going on at the present day. But similar masses, which have evidently flowed in streams from craters, are

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* Leonhard's Taschenbuch, 1824, Abth. ii, p. 439.

† Leonhard die Basalt Gebilde, t. i, p. 408.

‡ Cones of basalt, trachyte, and phonolite, whose inclination is often very considerable, cannot have risen in such a thin liquid state, as that in which lava issues from volcanos; for, according to the observations of Elie de Beaumont, already mentioned, lava streams having an inclination of only 6° cannot form a continuous mass. See on this subject, Leonhard, loco cit. t. i, p. 417, &c.

§ Felspar may certainly be considered as a characteristic sign of an igneous origin in rocks, as this mineral is never found in rocks, in the formation of which the action of volcanic power can be proved to have been wholly excluded.

also found in positions which shew that they must have risen from the interior of the earth, after the formation of the stratified rocks, and found their way into fissures, which in many cases do not reach the surface. Thus, granite, syenite, trachyte, the porphyries, the greenstone, and so on, up to the basalts, form dykes in the stratified rocks as well as in one another. They also not unfrequently appear in beds between the strata of the Neptunian rocks. Granites have been forced up to the surface at the most widely different periods; we find them most commonly in clay-slate, and in the greywacke formation, in gneiss and in mica-slate, and they are sometimes connected with other more considerable masses of granite. Even after the formation of the oolitic and chalk groups, they have been ejected; but there are no granitic dykes described as intersecting these rocks. The stratified rocks are usually altered in the immediate vicinity of masses or dykes of granite; and their stratification becomes indistinct and confused. The porphyries, like the granites, exist as independent formations; but these are not so frequent or so extensive, and are more frequently in contact with more recent stratified formations than the granites. The trap rocks traverse all the stratified rocks from the gneiss and greywacke group, at least to the oolites inclusively. The basalts are found in all formations, from the transition and secondary rocks to the lignite inclusively, nay, in the newest formations.*

In general, some alteration in the adjacent rock and some new mineral productions,† are found where such masses have been forced up, and large and small fragments of the rock are not uncommonly found firmly imbedded in the latter. We may here, by way of example, mention the conversion of compact limestones into marble, exactly as Hall changed limestones by heating them in close vessels or under pressure; and again, the disappearance of the black color and the bitumen in the coal sandstone.‡

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* Leonhard's Basalt Gebilde, t. ii, p. 6, &c.

† The adjacent rock, heated by the melting mass, might, by their both cooling very slowly together, give rise to the production of crystalline substances (as hornblende, felspar, mica, by the contact of granite with clay-slate.) But the rock would probably also take up substances from the melting mass (alkalies) which would serve as a flux.

‡ The combustion of beds of brown coal seems also to have been effected by igneous fluid masses which had risen from the interior. Thus the remains of such combustions always occur in *Bohemia*, according to Dr. Reuss, (Nöggerath Ausflug

The conglomerates which frequently surround these volcanic masses, and which are not confined to the basalts and trachytes, but are also found accompanying the greenstones, porphyries, and granites, Von Buch considers to be produced by the friction of the rising matter against the rock; and their existence is a further proof of the pyrogenetic origin of these masses.

Other phenomena lead us also to infer that crystalline rocks have risen in a melted state. If, for instance, such rocks are separated by rents, crystals are often found in them, broken through the middle, and both pieces are imbedded in the separated rocks. Thus, my friend Prof. Nöggerath has observed, that many of the larger crystals of glassy felspar in the trachyte of the *Drachenfels* are broken through in this manner, and that the one piece is displaced several lines from the other. He observed the same phenomenon more frequently in the porphyritic granite near *Göpfersgrün* in the *Fichtelgebirge*.* The olivine in the basalt of *Burzet* in *Vivarais*, presents the same appearance, according to Scrope,† and the separated portions of crystals exactly correspond. Faujas observed among the basalts of the bridge of *Bridon* adjacent columns, with included fragments of granite broken through, in consequence of the formation of the columns. All these phenomena prove that these crystalline rocks must have been still soft, after the imbedded crystals had arrived at the stage of perfect solidification, and that the breaking of the crystals is a consequence of cooling.

The occurrence of arragonite in the fissures and cavities of crystalline rocks, basalt, for instance, seems also, according to the above-mentioned experiments of G. Rose, to prove, that these rocks were at least still hot, when cold solutions of carbonate of lime penetrated into the fissures.

Lastly, instances of the formation of dykes of volcanic matter at the present day, offer a further proof, if further proof be necessary, of their igneous origin, and the accounts given of the recent eruptions at Ponohohoa in *Owhyhee*,‡ establish the possibility of eruptions through rents.

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nach Böhmen. Bonn. 1838, p. 171,) in the neighborhood of basalts, and these phenomena are so enormous, that they cannot be considered as caused by accidental combustion.

* Nöggerath loco cit. p. 71. See also Goldfuss and Bischof, Physikalisch-statistische Beschreibung des Fichtelbirges, t. ii, p. 114.

† Consider. p. 136.

‡ Poggendorff's Annal. t. ix, p. 141.

If alterations in the adjacent rocks, or other phenomena already mentioned, are not observed, we may infer that the elevations have taken place in a solid state. Notwithstanding this solidity, the highly elastic and exceedingly hot vapors may certainly cause considerable chemical alterations in the elevated masses, as well as in the adjacent rocks.

It is impossible to determine any regular order of succession in the elevation of the pyrogenetic rocks. They occur in every period of the stratified formations. Older ones have very commonly received those of more recent date into their fissures. There scarcely exists a single unstratified rock which is not somewhere to be found filling up dykes in granite. Basalt-dykes traverse many unstratified rocks, such as trachyte, conglomerate, and others. In *Iceland*, tufa is found alternating with slaggy lava; and dykes of a porous trachytic rock traverse the tufa of *Stromboli* and *Vulcanello* in the *Lipari Islands*, &c.*

Masses of melted matter will break through the bottom of the sea more easily, because resistance is there the least considerable. To this may be ascribed the frequent elevation of islands from the bottom of the sea, not only in historical times, but also at the present day, and under the eyes of observers, in whom the utmost confidence may be placed. The most extraordinary and instructive island in this respect is *Santorin*, because it unites the whole history of volcanic islands and islands of elevation. A more beautiful, regular, and perfect crater or elevation is not to be found, than in the space which is almost entirely surrounded by the inner circle of *Santorin* (which encompasses more than one-half of it) and by its continuation as exhibited in the islands of *Therasia* and *Aspronisi*.† Here it is probable that the clay-slate was broken through and upraised. These islands, therefore, form an inseparable whole, and cannot have been raised one after another. On the other hand, history and tradition inform us, that nature has never ceased in its endeavors to create a volcano in the centre of this crater of elevation. One hundred and eighty four years before the birth of Christ, the *Island* of *Hiera* (now called

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* De la Beche, Handbuch der Geognosie Von v. Dechen. Berlin, 1832. Abschnitt xi.

† Von Buch in Poggendorf's Annal. v. x, p. 172. See the drawing in his splendid atlas, and the sketch in these Annal. v. xxiv, p. 1.

*Palaia Kameni**) was formed, and since that, as it seems, many other rocks have been raised in its centre. In 1427, this island was increased. In 1573, the *Little Kameni* was thrown up, exactly in the centre of the basin, accompanied with an ejection of steam and pumice; and between 1707 and 1709, was raised the *New Kameni*, which still continues to send forth sulphurous vapors.† Lastly, in the present moment another new island seems to be about to appear to the east of *Kameni*, about 900 feet from the coast of *Santorin*, according to the report of a naval officer of *Santorin*,‡ (*Nauplia*, 4th December, 1834.) The inhabitants of the island assert, that thirty years ago this bank lay at the depth of 90 feet; in 1820, it was only 60 feet below the surface; and at present the sea is only 20 feet deep over it. According to later accounts given in the public journals, this bank continues to rise so rapidly, that if it meet with no interruption in its progress, it will, by the year 1840, be able to lay claim to the denomination of an island. In the year 1713, it is said an island arose among the small islands near *Venice*, accompanied with flames, smoke, and the most vehement shocks. This phenomenon, which continued four weeks, drove away the inhabitants from the adjacent islands. After about two years a similar occurrence was repeated, and a second island was thrown up under the same circumstances. These two islands are now, as the neighboring ones, inhabited and cultivated.§

From Leop. Von Buch's instructive exposition of the nature of volcanic phenomena,‖ which, together with the careful works of Von Hoff, contain a critical compilation of all cases yet known of the production of new mountains and islands by volcanic action, we will borrow only the following examples of recent date. The first I shall mention is the island of *Sabrina*, near *St. Miguel*, in the *Azores*, which is celebrated for the many islands that have

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* Von Hoff, Geschichte der natürlichen Veränderungen der Erdoberfläche, t. ii, p. 137. For an account of some crater-shaped islands, see Poggendorff's Annal. v. xxiv, p. 101.

† See the account of Father Bourignon in Raspe's specimen, &c. de novis a mare natis insulis, 1763, p. 48.

‡ Allgemeines Organ für Handel und Gewerbe, &c. No. 23. 1835; and Jameson's Phil. Journal, vol. xxi, p. 175.

§ Justi's Geschichte des Erdkörpers, p. 135.

‖ Poggendorff's Ann. v. x, p. 1 and following; p. 169, 345, and 514 and following.

attempted to rise in its vicinity, and which made its appearance on the 13th or 15th June, 1811; it began to disappear in October, and towards the end of February, 1812, steam was only occasionally seen to rise out of the sea at the spot where the island was formerly seen.* Secondly, The rising of a new island near *Unalaschka*, in May, 1796, which not only remained, but, up to 1806, had increased in circumference, as well as the peak in height. It required six hours to row round it, and rather more than five hours to ascend in a direct line from the shore to the summit of the peak.† The creation of both these islands was preceded by violent earthquakes, and columns of smoke, which ascended from the sea, whilst stones were thrown to a great distance. Of *Sabrina* this surprising circumstance is related—that the stones, on leaving the sea, were black, but suddenly became red hot when they emerged from the columns of smoke. Tillard found on this island the skeleton of a shark so calcined, that the bones fell to powder on lifting it up. Of the other island it is only said, that during the night fire rose, which was sometimes so bright, that all objects were distinctly visible in *Unalaschka*, at a distance of twenty leagues. Smoke continued to rise for four years.

Phenomena of this kind have taken place still more recently among the Molucca Isles, as we are informed by Prof. Reinwardt.‡ Near the active volcano of *Gonung Api*, in the group of the *Banda Islands*, a considerable mass of black rock rose up in a bay, out of the sea, without any noise. When Reinwardt visited this extraordinary spot in 1821, he found it still very hot, and the newly raised mass sent forth boiling hot vapors. A precisely similar occurrence took place on the coast of *Ternate*. On *Lancerote* also, on the 31st August, 1824, after several days of violent earthquakes, accompanied with a subterranean thunder like noise, a new volcano burst forth with a terrific crash, emitting streams of fire, so that the whole island was illuminated, and

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* See also V. Humboldt's Reise, t. i, p. 254, and t. iii, p. 6. It is worthy of remark, that the small island of 1720 has reached exactly the same height as *Sabrina* attained in 1811.

† It was, consequently, more than 1000 feet high. Unfortunately, the depth of the sea at that place is not given. But it certainly offers an example of one of the greatest elevations of the present day.

‡ De incendiis montium igni ardentium insulæ Javæ, &c. disputatio geologica. Auctore van der Boon Mesch. Lugduni Batav. 1826.

throwing up so many red hot stones and fragments of rock, as to form a mountain within twenty-four hours.*

The last occurrence we shall mention, and which is still fresh in our memory, namely, the volcanic island which appeared in July, 1830, in the *Mediterranean*, between the southwest coast of *Sicily* and *Pantellaria*, shews, that these phenomena may take place in two different ways. New islands may be formed in the sea either by the elevation of solid rock, by violently breaking and raising up the original strata, or merely by the heaping up of the loose masses which are ejected.† This event was of the latter description, and in its ephemeral existence exactly resembles the above-mentioned case in the *Azores*. Under which of these forms such volcanic productions appear, may depend on the nature and thickness of the rocks to be broken through, on the depth of the sea at the place of the eruption, and the strength of the volcanic force. However, the visible part of this island may, perhaps, as is the case with many others, only have been the summit of a peak situated in the centre of a crater of elevation, which remained buried in the sea, similar to the cones of many land volcanos, which, if they had been situated in the sea, would have been unable long to withstand the action of the waves, as is the case with most of these islands. Hoffmann,‡ who approached very near to this island, shortly after its appearance, saw quite plainly, that it was nothing else than the edge of a crater, the walls of which were gradually raised above the surface of the water by the materials ejected from it. From this crater vapors rose uninterruptedly with great violence, yet without noise, which were succeeded by the ejection of slags, sand, and ashes. The appearance of this island was also preceded by a noise resembling thunder, and by the elevation of a mass of black colored water to a height of eighty-two feet, columns of smoke rising at the same time to a great height. The accounts leave us in uncertainty respecting one of the most important circumstances—whether fire rose out of the crater or not. However, Hoffmann and his companions are inclined to the more probable opinion, that this volcano vomited no fire, and that what some observers took for

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* Annal. de Chim. et de Phys. t. xxvii, p. 382.

† See, on the contrary, Von Humboldt in his Reise, t. i, p. 254, note.

‡ Poggendorff's Ann. t. xxiv, p. 75.

flames, was only the *ferilli* in the smoke.* Lightning, caused by the electricity excited by the rapid evaporation, was observed there, as it is during the eruptions of *Vesuvius* and other igneous mountains. At the end of December, 1830, this island, which was 2100 feet in circumference, and the highest point of which rose 210 feet above the sea, shared the fate of *Sabrina*, and disappeared. From the bottom of the sea it had risen between 700 and 900 feet; and from what depth below, may be conjectured from the calculations previously given.

Thus, then, the rising of islands out of the sea, is a well authenticated fact, and if we should for a moment be left in doubt concerning the cause of this phenomenon, by the appearance of steam in the presence of the sea-water, yet the evolution of aqueous vapor from volcanic islands, enclosed on all sides by solid rock, seems to dispel such doubts.

Examples of elevations on land in historical times are much more rare. Of these we are only acquainted with the elevation of *Monte Nuovo*, near *Puzzuoli*, in 1528, which rose 400 feet in about three days; that of *Monte Rosso*, near *Catania*, in Sicily, in 1669, which rose to a height of 820 feet in about four weeks, and that of *Jorullo*, which rose to a height of 1480 feet above the plain, in one day, on the 29th September, 1759.†

These are also formed, like the volcanic islands, in two different ways. The *Monte Nuovo* was formed by the accumulation of the loose masses ejected from the volcano, whilst mountains of basalt, trachyte, phonolite, &c. which are so abundantly scattered over the surface of the earth, have been formed by the upraising of solid rocks.‡

*Vesuvius*, or rather its cone, seems also to present an example of an elevation in the historic area. Its formation perhaps does not go farther back than the period of the famous eruption of 79 after the Christian era, in which *Herculaneum* and *Pompeii* were destroyed; for ancient writers never speak of the mountain as

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* Without exactly wishing to generalize, this circumstance is yet sufficient to render us distrustful in judging of descriptions of similar phenomena in which flames are so often mentioned.

† Von Humboldt, Nouv. Espagne. v. ii. p. 290. See Burkart loco cit. vol. i, p. 226.

‡ The late investigations of Buch, Dufrenoy, and Elie Beaumont, show that the *Monte Nuovo* is a crater of elevation, therefore not entirely or chiefly composed of loose masses of ejected rocks.—*Ed. New. Phil. Journ.*

consisting of two peaks, which they probably would have done, if the *Monte Somma* had stood, as at present, distinct from the cone of *Vesuvius*.* It is also remarked that the distance mentioned in ancient writers, as intervening between the foot of *Vesuvius* and the towns of *Pompeii* and *Stabiae*, appears to have been greater than exists at present, unless we measure it from the foot of *Monte Somma*, so that this affords an additional probability, that the latter mountain was then viewed as a part of the former, and that no separation between them had at that time occurred. We may also be sure from the semicircular figure which the southern escarpment of the *Monte Somma* presents towards *Vesuvius*, that it constituted a portion of the walls of the original crater; and Visconti, it is said, has proved by actual measurements, that the centre of the circle, of which it is a segment, coincides as nearly as possible with that of the present crater. There seems, therefore, little room to doubt, that the old mouth of the volcano occupied the spot now known by the name of the *Attrio del Cavallo*, but that it was greatly more extensive than this hollow, as it comprehended likewise the space now covered by the cone, which was thrown up afterwards in consequence of the renewal of the volcanic action that had been suspended during so many ages. This view likewise tends, as it seems, to reconcile the accounts which ancient writers have given of the structure of the mountain, antecedently to the period before mentioned.†

As for the mode of action of the vapors, it is indifferent whether they have to contend with loose and unconnected, or with melting masses, only that the former are propelled into the air like cannon balls,‡ and falling into a parabolic curve, accumulate and

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* Daubeny, a Description of Active and Extinct Volcanos, &c. p. 144. See also Von Buch in Poggendorff's Ann. t. xxxvii, p. 173.

† See the Historical Notices given by Daubeny, loco cit. p. 145, and following.

‡ V. Humb. (Reise, v. i, p. 226) calculates from the time the stones thrown out during the lateral eruption of the *Peak of Teneriffe*, on the 9th June 1798, took in falling (which according to *Cologan* was from twelve to fifteen seconds, reckoning from the moment they reached their greatest height,) that they were projected to a height of more than 3000 feet. In some similar observations made by Von Humboldt during the eruptions of *Vesuvius* in 1805, he satisfied himself that such observations are capable of a great degree of exactitude. Similar calculations made by other observers, give still greater heights. The maximum height of such projections was observed at *Cotopaxi* by La Condamine (Voyage à l'Equateur.) He saw propelled laterally, a block of about 1000 square feet, to a distance of nearly 1½ geographical miles.

produce a mountain, whilst the latter remain at the height to which they are borne up by the elastic fluids.

In elevations of the latter description, the vapor cannot escape through the uplifted mass. This mass is supported by the elastic force of the vapor, cools gradually, and then remains, as it were, wedged in between the strata it has broken through. But according to Von Buch's* observations on *Palma* and *Gran Canaria*, it may happen, that the vapor bursts forth from the centre of the mass it has raised, and thus exposes its interior. Such a crater would thus be the effect of the elevation of the island, for which reason he gives it the name of crater of elevation, (Erhebungs Krater,) to distinguish it from the craters of eruption, by which true volcanos open a communication with the atmosphere.

Further, this philosopher has pointed out,† that volcanic cones cannot be generated by the building up of streams of lava. He infers this from observations made by Elie de Beaumont, and which have been already alluded to. This philosopher measured the mean inclination of about thirty lava streams of *Etna*, and of a great many of *Vesuvius*, and found that a stream having an inclination of 6°, or even more, forms no continuous mass. Such a stream inclines too much to be able to attain more than a thickness of a few feet. When its inclination is only 3° or less, the mass may be spread, and accumulated to a considerable height.‡

Lastly, we have to notice the upraisings which are the consequences of earthquakes, and often extend to large islands and whole tracts of country. Elevations of small compass, accompanied by partial depression, which is no doubt merely a consequence of the elevations, were observed before,§ and during‖ the famous earthquake of *Lisbon*. Small elevations also took place during that in *Calabria*.¶ The commissioners who were employed to make observations of the earthquakes in the county of *Pigneral*, relate, that the very day (2d April, 1808) when one

* Abhandlungen der Berliner Acad. loco cit. p. 58.

† Poggendorff's Annal. t. xxxvii. p. 170, &c.

‡ Vied Memoire of Elie de Beaumont, in vol. xx. p. 376, &c. Edin. New Phil. Journ.; and Description Geologique de la France, t. iv.

§ Palassou Mém. pour. servir à l'Histoire Nat. des Pyren. p. 260.

‖ Philos. Trans. t. xlix. p. 417. ¶ Jour. de Phys. lxii. 1806. p. 264.

of the most violent shocks was felt, the masting engine at *Toulon* was elevated more than an inch.* This observation is worthy of note, as it shows that many effects of earthquakes may often take place at great distances from their seat, which, owing to their minuteness, may escape observation, unless casually discovered. For accounts of elevations of a more considerable kind in equatorial countries, we are indebted to Humboldt. The elevations in the island of *Lancerote*,† and those on the coast of *Cumana*,‡ are of this kind.

The most remarkable instance of the elevation of great tracts of country of late years, is that which took place in *Chili*, on the 19th November, 1822. For the account of this important phenomenon we are indebted to Mrs. Maria Graham, a well informed observer.§ After violent earthquakes, which were felt through an extent of country 1400 English miles in length, and during which, it appeared as if the soil was suddenly raised and immediately sunk again, or as if the earth had an undulating motion from north to south, accompanied with a noise like the rushing of steam, the whole coast for an extent of about 100 English miles, actually rose between three and four feet within twenty four hours.‖ In all the small valleys the earth in the gardens was disturbed, and sand and water rose in quantities through the cracks. The granite rocks near the coast, which are traversed by small parallel dykes, showed many narrow rents parallel to the old ones in some instances. The former were traced one mile and a half inland. The phenomena which most forcibly arrested the attention of Mrs. Graham, were evident marks of this coast having been raised in a similar manner by earthquakes in former times, and indeed to a height of fifty feet above the sea level.

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* Idem, t. lxvii. 1808. p. 308.

† Relat. Hist. t. i. p. 188.

‡ Ibid. t. ii. p. 279.

§ Geol. Transact. v. i., Sec. Series, part ii. p. 413. Mr. Greenough felt disposed to call in question the observations of Mrs. Graham, but she has defended her statements very creditably, and has been supported by Mr. Meyen, Berghaus Annal. der Erdkunde, t. xi. p. 129.

‖ Fr. Place also confirms this account of the extent of the elevation, in Journ. of Sc. No. xxxiii, p 36. According to the reports in the Ann. de Chim. et de Phys. t. xxvii, p. 350, two volcanos, in the neighborhood of *Valdivia*, presented a sudden eruption with a loud noise, and illuminated the whole country for some seconds, but they soon subsided again. At the same time a slight shock was felt in that town.

The latter phenomena are so much the more important the more frequently they occur. We can, therefore, have no difficulty in admitting most earthquakes to have been the causes of such elevations. Many coasts, as is well known, bear evident marks of having been raised in former times. Thus Vetch* observed on the coast of the island of *Jura*, in Scotland, six to seven terraces one above another, the lowest at the level of the sea, the highest about forty feet above it, all covered on their horizontal surfaces with pebbles like those which the sea still throws up. Mr. Smith of Jordanhill has also pointed out, that in a former time an elevation of the west coast of *Scotland* has taken place.† Peron noticed a similar phenomenon on the coasts of some islands in the neighborhood of *Van Diemen's Land.* Many other instances of this kind occur, which present traces of elevations, some of them perfectly incontestable,‡ others very probable.§ In conformity with this, are also the assertions of the inhabitants of *Otaheite*,‖ and those of the *Moluccas*,¶ that their islands still continue to rise.

The latest earthquakes, which, in the month of February, 1835, destroyed a great part of *Chili*, (*Conception*, and many other towns,) offer also evident proofs of elevations occasioned through their agency. Some days after this devastation the sea did not rise to its ordinary level, the difference amounting to four or five feet in height. This difference decreased gradually; in the middle of April it was still two feet. The fact that the island of *Santa Maria* has risen nine feet, proves the actual elevation of the country. Near *Tubul*, southeast of *Santa Maria*, the country has risen six feet, and the island of *Mocha* seems to have risen about two feet.**

The gradual elevation of *Scandinavia* and *Finland* is peculiarly interesting. More than a century ago, Celsius called attention to this phenomenon, and endeavored to account for it by

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* Geological Trans. Sec. Series, v. i. part ii. p. 416.

† Phil. Mag. v. x. p. 136; Jameson's Phil. Journal, vol. xxv. p. 378; and Mem. Wernerian Soc. vol. viii. part i. in the press.

‡ Dolomieu Oryktol. Bemerk. über Calabrien. Frankf. u. Mainz 1789, p. 157.

§ Brochi in Biblioteca Italiana 1821. Sept. Breislak Reisen in Campanien, t. ii. p. 115.

‖ Correspondence Astronomique, v. x. p. 266.

¶ Poggendorff's Ann. t. ii. p. 444, according to Prof. Reinwardt.

** Nautical Magazine, No. 49 and 51. March and June, 1836.

a gradual sinking of the level of the *Baltic*. Playfair,* however, remarked, as early as the year 1802, that an elevation of the land may be assigned as the cause of this phenomenon with more probability than a sinking of the water. This supposition, he thinks, accords with Hutton's theory, according to which the continents have been actually raised by subterraneous powers, and are even now supported by them in their place. Lastly, Von Buch,† without having seen Playfair's work, gave his opinion, "that the whole country, from *Frederickshall* in *Sweden* to *Abo* in *Finland*, is in the act of rising slowly and insensibly." The rising of the Gulf of *Bothnia* amounts, according to the observations communicated by Hällström, from 3.71 to 4.61 feet; on an average 4.26 feet during a century.‡ Beds of sea-shells, found sometimes 200 feet above the present level of the sea, as, for instance, on the sea-coast and on the islands of *Uddevalla*, as also on all the sea-coasts of the south of Norway, and which sea-shells consist of such kinds as are still found living at these places in the sea, prove how much the level of the *Baltic* has changed even during the time that the present testacea have inhabited it.§ But the rising seems to be very unequal at various places. In the north it is more considerable than in the south. On the eastern coast of the *Danish* islands of *Möen* and *Seeland*, Lyell‖ found no indication of a recent elevation of land. The first place along the whole coast of the *Baltic*, where an elevation is said to have taken place, is the town of *Calmar*. Beyond the *Swedish* coast, on the coast of *Finland*, the inhabitants are perfectly convinced, either that the water sinks or the land rises. This remarkable phenomenon has excited a general interest among the Swedish naturalists, and caused continual exact observations of the marks inscribed on the shores of the Gulf of *Bothnia*. Thus Nilson¶ thinks he has found convincing proofs that the most southern part of *Sweden* is sinking, whilst the remaining part is rising. He has also endeavored to

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* Illustrations of the Huttonian theory.

† Reise durch Norwegen und Lappland, t. ii. p. 389.

‡ Brunerona u. Hällström in Poggend. Ann. t. ii. p. 308.

§ Berzelius Jahresbericht, 1826, p. 292.

‖ Poggendorff's Ann. t. xxxviii, p. 64.

¶ Berzelius Jahresbericht, No. 18, p. 386, and Poggendorff's Ann. t. xlii, p. 472.

give probability to the supposition, that the sinking took place, and still takes place, not suddenly, but gradually. Forchhammer* likewise alluded to similar phenomena, in order to prove that elevations in *Scandinavia* take place not only in different proportions, but that a depression is also going on. He infers from his observations, that the level of the coast of Denmark has varied in a different proportion from that of the *Swedish* coast, which he ascribes to the feeble earthquakes that have been felt so often in *Sweden*, but never in *Denmark*. He estimates, according to rough calculations, the elevation of the island *Bornholm*, to amount to one foot in the course of a century.

If elevations of countries, in which volcanic actions are felt, and which are agitated by violent earthquakes, be produced, as is very probable, by the same causes as these phenomena, yet it is difficult to imagine these causes to operate in elevating countries where no such phenomena occur, or where, at least, they take place but rarely, or to a small extent. The latter is the case in the *Scandinavian* Peninsula. That region has no active volcanos, no hot springs—even thermal springs bearing a temperature of but a few degrees higher than the mean temperature of the place, are considered as rarities; whilst, in other countries, they are of very frequent occurrence. All this proves that the crust of the earth in this country must be very solid, and traversed by comparatively few rents or fissures.

Berzelius assigns as the cause of this rising of the *Swedish* coast, the gradual cooling of the earth; and says: "Its diameter, in this manner, decreases, and the consolidated crust leaves either empty spaces between itself and the fluid mass, or sinks downwards. Being, however, of so large an extent, that foldings and bendings must occur, portions must rise up on one side and sink on the other. This supposition seems to be supported by the sinking of the western coast of *Greenland*, and of an island situated in the Gulf of *Youghall*, a phenomenon which has been recently pointed out by Elie de Beaumont and Pingel. Klöden also has recently given much probability to the supposition of a sinking of the *Dalmatian* coast.†

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* Phil. Mag. ser. iii, v. ii, p. 309, and Poggend. Ann. t. xlii, p. 476.

† Poggendorff's Ann., t. xliii. p. 361.

We shall endeavor to show in our next section what effect might be expected on the surface of the earth, if its solid crust should still continue to increase in thickness towards the interior by gradual consolidation of the fluid centre. Besides, I think that a sinking of the outer crust can scarcely be supposed to occur, but that it is much more probable that caverns should be formed at the moment when the fluid mass becomes solid. At least the latter effect was seen in fusing two basalt balls, two feet in diameter, in which many larger and smaller cavities were found. I shall allude to these phenomena in another section.

If we take into consideration all that has been already said on ejections and elevations, (*soulevèmens*,) we shall be induced to adopt the following inferences. Masses of our earth, still in a fluid state, may be raised through and above its solid crust. The rising of the lava in the craters of volcanos is a satisfactory proof of this circumstance. Solid rocky masses, strongly heated, may be pushed upwards during violent convulsions, and elevations of the original rocky covering, or be thrown up in the form of loose masses, more or less heated. The not unfrequent rising of small islands from the bottom of the sea, and the elevations (*soulèvemens*) actually observed to take place in the continents, are evidences of these operations. All these phenomena are effects of forces, which develope their whole intensity in a very short time, often in a few moments. But large islands, and even whole countries may, in a very short time, be raised several feet, as was shown in the cases of *Chili* and *Santa Maria*. On the other hand, *Scandinavia* presents us with an instance of an elevation which, compared with the preceding, takes place with extraordinary slowness.

Besides all these elevations which have been actually observed, other appearances occur, which lead us to infer that elevations have taken place previous to the existence of any record. These are the elevations of old volcanic masses, as basalt, trachyte, &c., their penetration into fissures, and the elevation of whole systems of mountains. In regard to the first, the conclusion may, as has been already shown, be considered as well founded as it is generally possible to be, when drawn from phenomena which have taken place before any records were in existence. The similarity between these phenomena, and those which have taken, and still take place, before our eyes, render it extremely probable that they

were produced by forces which were in operation for a very short period only. Changes in the contiguous rocks, and the imbedment of fragments of them in the volcanic rocks, render it also equally probable that these masses were raised in a fluid, or at least softened state, and either rose above the surface of the earth in the form of conical mountains, or remained adhering in rents of the rocks. These phenomena, then, belong entirely to the same class as the elevations of lava in volcanic craters. When, on the other hand, no changes are perceived in the contiguous rocks, when these have been simply broken through and upraised, when the broken masses consist of acute-angled fragments of all dimensions heaped one upon another, then we cannot assume that the elevations took place in a fluid or softened state.

Were elevations of this kind the work of a short space of time, or did they proceed slowly? In vain do we look around us for some clew to the solution of this question. From physical grounds we are led to the following conclusions. If fused rock come in contact with water in the interior of the earth, the watery vapor disengaged, will operate, with the whole expansive force which it can acquire from the heat of the rock, in a short time; provided that the continued formation of vapor be not limited by want of water. It is the same process as that which takes place in the glass-blower's blow-pipe when he forms large globes. If, then, water acts on fused masses in a confined space, we have the conditions requisite for producing a rapid elevation, and therefore, as a general rule, we may regard elevations of fused masses and rapid elevations as co-ordinate phenomena. If, on the other hand, we imagine a solid rock deep under the surface, whose temperature is far below a red heat, then its elevation can take place only when a considerable source of heat exists under the rock, which gives rise to the formation of vapor. But the more the heat of the vapor exceeds that of the rock, which is to be raised and supported by it, the more will it become condensed, and thus a great part of the effect is lost. If the condensed vapor return to the source of heat, it will again assume the form of vapor, and thus a constant circulation will ensue. It is actually a process of heating by steam. If the solid rock be a very bad conductor of heat, then that surface which is in contact with the vapor, may gradually acquire its temperature, and the vapor thus attain its maximum of operative force. It naturally depends

on the weight of the solid mass, whether the vapor can effect its elevation, and by what elasticity. Although we must suppose that the elastic force of the vapor progressively increases, in proportion as the temperature of the surface of rock in contact with it rises; yet, on the other hand, we must consider, that when the vapor, which had not yet attained its maximum of expansive force, has effected an elevation, then, a regressive effect, as regards duration of time, will ensue, because, by the elevation, the space which confined the vapor has become enlarged. Secondly, if the conducting power of the solid mass be greater than we have just assumed it to be, then the heat, which is communicated to the surface of contact by condensation of vapor, is as quickly diffused above, as it can be conveyed from the vapor below, and if the latter produce a continued elevation, the effect must inevitably be regressive. We can therefore conceive it possible, under the conditions stated, that the same force, viz. vapor of water, which, when in contact with a fused mass, developes its whole intensity in a short time, can produce only a gradual effect, when in contact with solid masses whose temperature is far below that of the vapor. We thus see the possibility of fused masses being raised by vapor in a short time, while solid masses may be raised very slowly by the same agent, and that the latter elevation may go on in a regressive ratio. Lastly, it is even possible that a gradual elevation of a solid mass may continue, although the elevating effect of the vapor has long ceased. For instance, if the subterraneous heating by steam continue, and if the heat, communicated to the surface of contact by condensation of the vapor, be diffused above more slowly than it is conveyed below, then it is clear that the solid mass, supported by the vapor, will gradually be expanded.

These remarks have shown that the operations of vapor, as an elevating force, may be very various as regards the relations of time and space, and that its effects depend not only on its own temperature, but also on that of the masses it has to elevate, on their relative conducting power, and lastly, on the capacity of the space within which its operations take place.

We can therefore understand how the slow elevation of *Scandinavia* may be the result of the operation of watery vapor, taking place in a diminishing ratio, and how therefore this phenomenon stands in close connexion with the original elevation of that

country, which is principally composed of masses of igneous origin. We shall pass over the consideration of the question, whether this original elevation took place in a fluid or solid state, that is, whether in earlier times these masses rose suddenly and continued to rise more and more slowly as they gradually cooled, or whether this gradually decreasing ratio has always existed. We may, however, be allowed the remark, that the slow elevation which still continues when the operation of the vapor, as an elevating power, has long ceased, may be regarded, according to what has been stated above, as the result of an expansion produced by the caloric disengaged from the vapor during its condensation. For example, let us assume that the solid crust of the earth in *Scandinavia* was 139,840 feet thick, that the expansion of this crust by heat takes place in the same ratio as in earthern ware; then, an average increase of heat of 2°.9 R. during the space of 1000 years, would be sufficient to effect an expansion of 4.26 feet in a stratum of the above-mentioned thickness. And this is the average ratio of the rising of that country.

Be the cause of the elevation of *Scandinavia* what it may, this circumstance is remarkable, that in the southern part of *Sweden*, where the country, according to Nilson's statement, sinks, secondary formations, viz. chalk, occur in great abundance, while in the north of *Sweden*, as well as in *Finland*, the gneiss-granite formation predominates. We must not, however, attach too much importance to the connexion which appears to exist between the elevation of the northern part of *Sweden* and the prevalence of the latter formation, as Nilson* says, the chalk also lies on gneiss, and less frequently on greywacke. It is neverthless remarkable that the granite island of *Bornholm*, which is situated opposite to the sinking coast of *Schonen*, is still in the act of rising, according to the observations of Forchhammer above alluded to.

As regards the sinking of countries, there is no difficulty in regarding it as the result of an elevation of neighboring countries. Yet we can imagine many causes, independent of such elevations, which may produce depressions. It does not, however, lie within the scope of these remarks to enumerate these causes.

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* Petrificata Suecana Form. Cretaceae, &c. 1827, p. 81.

It remains to consider the elevations of whole systems of rocks, events which must have taken place prior to the existence of our records. There is doubtless no difficulty in also explaining these phenomena through the agency of steam. Elie de Beaumont,* however, is of opinion, that these elevations are a consequence of the inequality between the cooling of the interior and exterior of the earth. We shall examine this subject, after pointing out the laws that prevail during the cooling of large masses of fused matter.

To be continued.

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ART. III.—*Descriptive Catalogue of the North American Insects belonging to the Linnæan Genus* SPHINX *in the Cabinet of* THADDEUS WILLIAM HARRIS, M. D., Librarian of Harvard University.

THE insects belonging to the order Lepidoptera have peculiar claims to our attention. In the adult or winged state they are among the most beautiful, and in their previous or caterpillar state are the most injurious of insects. Living while young principally on the leaves of plants, they are at all times more or less exposed to our observation, and too often obtrude themselves on our notice by their extensive ravages. While it is comparatively easy to discover these insects and observe their transformations, the determination of their names and their places in a scientific arrangement is rendered in many cases impossible, and in all exceedingly difficult, to the American student, from the want of suitable descriptive works on this branch of entomology. Having overcome these difficulties myself only at a great expense and much loss of time, it has occurred to me that a descriptive catalogue of our Lepidoptera might be useful to others, while it would serve to confirm the names given to these insects in my cabinet, and transmitted in return for specimens to my friends. My own collection has now become quite extensive, and contains a large number of undescribed species from various parts of the United States. Passing by our Butterflies, nearly all of which have been

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* Poggendorff's Annal. vol. xxv, p. 55.

figured and for the most part described in Dr. Boisduval's "Histoire et Iconographie des Lepidoptères de l'Amérique Septentrionale," I propose, at the present time, to offer for publication descriptions of the native insects in my collection belonging to the second grand division of the order Lepidoptera, comprising the Sphinges of Linnæus. Should these be favorably received, they may hereafter be followed by descriptions of our Phalænæ or moths. The larvæ or caterpillars of many of the species are described partly from my own observations, and partly from the figures given by Mr. Abbot in his great work, on the Lepidoptera of Georgia, edited by Sir James E. Smith. My obligations to the gentlemen who have favored me with specimens will be found recorded on almost every page of this catalogue, and I beg leave to tender to them my most grateful acknowledgments, and to solicit from them, and from others, a continuation of similar favors.

Linnæus was led to give the name of Sphinx to the insects in his second group of the Lepidoptera, from a fancied resemblance which some of their larvæ, when at rest, have to the Sphinx of the Egyptians. The attitude of these larvæ is indeed very remarkable. Supporting themselves by their four or six hind-legs, they elevate the fore-part of the body, and remain immovably fixed in this posture for hours together. In the winged state the true Sphinges are known by the name of humming-bird moths, from the sound which they make in flying, and hawk-moths, from their habit of hovering in the air while taking their food. These humming-bird or hawk-moths may be seen during the morning and evening twilight flying with great swiftness from flower to flower. Their wings are long, narrow, and pointed, and are moved by powerful muscles, to accommodate which their bodies are very thick and robust. They delight most in the honeysuckle and scarlet Bignonia, from the tubular blossoms of which they extract the honey, while on the wing, by means of their excessively long maxillæ or tongue. Other Sphinges fly during the day-time only, and in the bright sunshine. Then it is that our large clear-winged Sesiæ make their appearance among the flowers, and regale themselves with their sweets. The fragrant Phlox is their especial favorite. From their size and form and fan-like tails, from their brilliant colors, the swiftness of their flight, and the manner in which they take their food, poised upon

rapidly vibrating wings above the blossoms, they might readily be mistaken for humming-birds. The Ægeriæ are also diurnal in their habits. Their flight is swift, but not prolonged, and they usually alight while feeding. In form and color they so much resemble bees and wasps as hardly to be distinguished from them. The Smerinthi are heavy and sluggish in their motions. They fly only during the night, and apparently take no food in the winged state, their maxillæ or tongues being so short as to be useless for this purpose. The Glaucopididæ, or Sphinges with feathered antennæ, fly mostly by day, and alight to take their food like the Ægeriæ, to which some of them bear a resemblance, while others have nearly the form of Phalænæ or moths, with which also they agree in their previous transformations.

### SYNOPSIS OF THE FAMILIES AND GENERA.

It was not my intention originally to give here the characters of the genera, but to refer the student for them to the works of Latreille and other entomologists. Upon further consideration, however, I have thought that the labor of determining our Sphinges by means of the catalogue would be much abridged, if a synopsis of the families and genera were to be prefixed to it.

## Class Insecta.

Animals with jointed bodies, breathing through lateral holes or spiracles, produced from eggs; while growing subject to a transformation of three stages; in the first stage called larvæ, caterpillars, grubs, or maggots; in the second pupæ, nymphs, or chrysalids; in the third stage provided with wings, a body composed of three distinct parts, the head, thorax or trunk, and the abdomen, and having two compound eyes, two antennæ, from two to six palpi or feelers, and six legs.

## Order Lepidoptera.

The young, called larvæ or caterpillars, are provided with jaws, and from ten to sixteen legs. They feed principally upon vegetable substances. The pupæ take no food, are incapable of moving about, are apparently without legs, these parts with their other members being folded up and firmly soldered to the body. In the third stage they are, with few exceptions, provided with four wings, which, with the body, are more or less covered with little colored branny scales, lapping over each other like the scales of fishes; their jaws are transformed to a tongue, more or less long, and, when not in use, spirally rolled and concealed between the palpi.

### Section I.—Papiliones.

Antennæ threadlike and knobbed or thickened at the end. Wings not confined by a bristle and hook; all of them, or the first pair at least, elevated perpendicu-

larly, and turned back to back when at rest. Only one pair of spurs to the hind-legs in the greater number. Thorax moderate; abdomen rather slender. Flight diurnal. Larvæ with sixteen feet; transformation in the open air. Pupæ angulated, and fastened by silken threads, or ovoid, and enclosed in an imperfect cocoon.

## Section II.—Sphinges.

Antennæ thickened in or just beyond the middle, tapering at each end, and most often hooked at the tip; more rarely slender and nearly setaceous, with a double row of slender teeth or hairs on the under side in the males. Wings confined by a bristle or bunch of stiff hairs on the front edge near the shoulder of each hind-wing, which is retained by a hook on the under side of each fore-wing; when at rest horizontal, or inclined on the sides of the body, the fore-wings covering and concealing the hind pair. Two pairs of spurs to the hind-legs. Thorax thick and robust; abdomen mostly conical. Flight of some in the morning and evening twilight, of a few nocturnal, and of others during the day. Larvæ with sixteen legs; transformation in or upon the ground, or in a silken cocoon. Pupæ elongated ovoid.

## Section III.—Phalænæ.

Antennæ (never knobbed at the end or thickened in the middle) slender and tapering to a point, in some pectinated or feathered, in others simple or bristle-formed. Wings confined together by bristles and hooks, the first pair covering the hind-wings and horizontal or sloping when at rest. Two pairs of spurs to the hind-legs. Flight for the most part nocturnal. Larvæ with from ten to sixteen legs, transforming in a silken cocoon or in the ground. Pupæ ovoid.

The Sphinges may be divided into two tribes.

## Tribe I.—Sphinges legitimæ.

Larvæ colored, naked, for the most part horned on the tail, and feeding on the leaves of plants; or whitish, slightly hairy, not horned, and living on woody matter within the stems of plants. Antennæ of the winged insects tipped with a minute bristly tuft.* Palpi (except in the Ægeriadæ) with the third joint minute and indistinct.

## Tribe II.—Sphinges adscitæ.

Larvæ always colored, more or less hairy, never horned, feeding on leaves, and transforming in a silken cocoon, which is fastened to the plants on which they live. Antennæ of the winged insects not tufted at the end. Palpi distinctly three-jointed.

The first tribe, or Sphinges legitimæ, may be divided into three families.

### Family I.—Sphingiadæ.

Antennæ fusiform and prismatic; ending in a hook, and, in the males, transversely biciliated beneath; or, more rarely, curved, and, in the males, bipectina-

* This little tuft is obsolete or wanting in the *Smerinthi*.

ted beneath. Palpi pressed close to the face, short, thick, and obtuse, with the third joint minute and concealed. Body thick; abdomen conical and not tufted at the end. Flight crepuscular. Larvæ colored, naked, with a caudal horn, which is sometimes obsolete and replaced by a callous spot; they devour the leaves of plants, and go deep into the earth to transform, or conceal themselves upon the surface, under leaves, in an imperfect cocoon.

**The North American genera in this family are six.**

## Genus I.—Smerinthus.

Wings more or less angular and indented, the front margin of the hind-wings projecting beyond the upper or fore-wings when at rest. Antennæ short, prismatical and fusiform, arcuated or curved near the tip, transversely biciliated or bipectinated beneath in the males. Tongue obsolete. Larvæ granulated, with the head triangular, horned on the tail, obliquely banded on each side, and transforming in the earth.

## Genus II.—Ceratomia.

Wings entire. Antennæ elongated, abruptly ending in a short and slender hook, transversely biciliated beneath in the males. Palpi horizontal and nearly cylindrical. Tongue moderate. Abdomen longitudinally striped. Larvæ with horns on the fore-part of the body, a row of little teeth on the back, a long caudal horn, and oblique bands on each side; it transforms in the earth.

## Genus III.—Sphinx.

Wings entire. Antennæ long, abruptly ending in a short and slender hook, and transversely biciliated beneath in the males. Palpi rising and enlarged at the end. Tongue long. Abdomen spotted or transversely banded at the sides. Larvæ with oblique bands on the sides and a caudal horn, and transforming in the earth.

## Genus IV.—Philampelus.

Wings sinous. Antennæ long, attenuated at the end, with a long terminal hook, and transversely biciliated beneath in the males. Tongue moderate. Abdomen not transversely banded or spotted at the sides. Larva short, thick, with the head and first three segments rather small and capable of being drawn more or less within the fourth segment; when young with a long, slender, recurved caudal horn, which subsequently disappears and is replaced by a callous spot; sides with oblique spots sloping backwards and downwards; transforms in the earth.

## Genus V.—Chœrocampa.

Wings sinous or angulated. Antennæ rather short and slender, generally arcuated, tapering, and ending in a long hook; more rarely straight, with a short terminal hook; transversely biciliated beneath in the males. Tongue moderate. Abdomen immaculate, or longitudinally striped, but never transversely banded at the sides. Larvæ elongated, the fore-part of the body tapering and retractile; with from one to three eye-like spots, or a series of oblique bands on each side; caudal horn short, sometimes obsolete and replaced by a callous spot; transforms on the surface of the ground, under leaves, in an imperfect cocoon.

## Genus VI.—Deilephila.

Wings entire, upper ones acute. Antennæ rather short, straight, gradually thickening nearly to the end, which suddenly terminates in a small and short hook; in the males transversely biciliated beneath. Tongue moderate. Abdomen conical, pointed, and transversely banded at the sides. Larva elongated, not tapering before, and the head and first three segments not retractile, with a series of nine or ten round spots on each side, and a long caudal horn; transforms in the earth.

## Family II.—Macroglossiadæ.

Antennæ *fusiform*, prismatic, ending with a *hook*, and transversely biciliated beneath in the males. Palpi pressed close to the face, with the third joint minute and concealed; short, thick, and obtuse at the end in some; slightly elongated and subacute in others. Body short and thick, or flattened a little; abdomen tufted at the end. Flight diurnal. Larvæ colored, naked, with a caudal horn, which is sometimes obsolete and *replaced by a callous spot; they devour the leaves of* plants, and enter the earth to transform, or conceal themselves upon the surface in an imperfect cocoon under leaves.

In this family we have three genera, Pterogon, Thyreus, and Sesia.

## Genus VII.—Pterogon.

Wings angulated and indented. Antennæ long, arcuated, tapering at the end, with a long, terminal hook. ——— Tongue as long as the body. Abdomen short and conical. Larvæ attenuated before, with a series of spots, on each side, sloping obliquely backwards and downwards, and a caudal horn, which is frequently obsolete and replaced by a callous spot: they transform in an imperfect cocoon under leaves.

## Genus VIII.—Thyreus.

Wings angulated and indented. Antennæ long, and ending with a long hook. Palpi short, thick, and obtuse at the end. Tongue moderate. Abdomen ovoid. Larvæ elongated, not attenuated before, longitudinally striped on the back, obliquely banded at the sides, with a long and straight caudal horn: they transform in the earth.

## Genus IX.—Sesia.

Wings entire, upper ones acute, all of them transparent in the middle. Antennæ short, straight, gradually thickened towards the end, with the terminal hook obsolete, and obliquely biciliated beneath in the males. Palpi somewhat elongated, subacute, and forming a conical beak. Tongue long. Abdomen short ovoid, slightly flattened. Larvæ not attenuated before, longitudinally striped on the back, with a short, slightly recurved caudal horn: they transform in an imperfect cocoon under leaves on the surface of the ground.

## Family III.—Ægeriadæ.

Antennæ arcuated; either thickening to beyond the middle, attenuated and curved but not hooked at the end, and biciliated beneath in the males; or very slightly fusiform and almost threadlike, and simple in both sexes. Palpi elongated, slender, distinctly three-jointed, prominent, separated and not pressed close to the head, nearly cylindrical, covered with very small scales and almost naked ex-

cept at the base, which is hairy, and pointed at the tip. Wings more or less transparent. Abdomen with a caudal tuft. Flight diurnal. Larvæ whitish, soft, slightly downy, living within the stems of plants, and generally transforming in a cocoon made of fragments of wood and bark cemented by a gummy matter. Pupæ with the edges of the abdominal segments armed with transverse rows of small teeth.

The American species in this family may be disposed in the genera Trochilium, Ægeria, and Thyris.

## Genus X.—Trochilium.

Wings narrow, entire, all of them, or the hind-pair at least, transparent. Antennæ short, stout, arcuated, gradually thickened nearly to the end, which is curved but not hooked; underside generally fringed with a double row of very short bristles in the males. Tongue very short. Body thick; abdomen slightly tufted at the end.

## Genus XI.—Ægeria.

Wings narrow, entire, all of them, or the hind-pair at least, transparent. Antennæ mostly elongated, sometimes short, arcuated, gradually thickened nearly to the end, which is curved but not hooked; underside generally fringed with a double row of short bristles in the males. Tongue long. Body slender; abdomen nearly or quite cylindrical, ending with a flat or trilobed tuft.

## Genus XII.—Thyris.

Wings broad, subtriangular, more or less angulated and indented, opaque, with small semitransparent spots. Antennæ fusiform, but slender and only slightly thickened in the middle, arcuated, and simple in both sexes. Tongue moderate. Body short and thick; abdomen conical, and tufted at the end.

# Tribe II.—Sphinges adscitæ.

The species described in this catalogue may be disposed in three families, Agaristiadæ, Zygæniadæ, and Glaucopididæ.

## Family IV.—Agaristiadæ.

Antennæ straight, slightly thickened in or beyond the middle, and curved at the tip. Palpi elongated, slender, not pressed to the face, hairy at base, with the terminal joint cylindrical, scaly or almost naked. Wings broad, subtriangular. Tail hairy or tufted. Flight diurnal. Larvæ elongated, cylindrical, or enlarged a little behind, slightly hairy, transversely banded or spotted, and without a caudal horn.

## Genus XIII.—Alypia.

Wings broad, subtriangular, entire, and opaque, with large whitish spots. Antennæ somewhat elongated and slender, thickened very gradually from beyond the middle nearly to the tip, which is slightly curved, obtuse, and not tufted. Palpi long, porrect, separate, with the first two joints very hairy, and the third joint cylindrical, scaly, and obtuse. Tongue moderate, and spirally rolled. Abdomen somewhat elongated, nearly cylindrical, fringed at the sides and tip with short hairs. Anterior and intermediate tibiæ thickly clothed with hairs. Posterior tibiæ with two pairs of pretty long unequal spurs.

## Family V.—Zygæniadæ.

Antennæ arcuated, abruptly thickened and curved beyond the middle. Palpi generally elongated, sometimes short, not pressed to the face, hairy at base, with the terminal joint scaly or almost naked. Wings narrow, opaque, often spotted, the hind-pair rather small. Abdomen more or less cylindrical, obtuse, and not tufted at the end. Flight diurnal. Larvæ short, contracted, variegated with spots, slightly hairy, and not horned on the tail.

### Genus XIV.—Mastigocera.

Wings long, narrow, entire, opaque, the hind-pair quite small. Antennæ simple in both sexes, filiform at base, suddenly thickened and fusiform beyond the middle, very much attenuated towards the tip, and ending in a long curved point. Labial palpi somewhat curved, extending considerably beyond the clypeus, separated, well covered with hairs beneath the base; the penultimate joint longest, cylindrical, and scaly; the last joint also cylindrical, obtusely rounded at the end, and covered with small, close scales. Maxillæ (tongue) nearly as long as the body. Abdomen nearly cylindrical, obtusely rounded at the end, longitudinally grooved at the sides before, with the basal segment strongly marked, and swelling on each side into a little tubercle. Legs long and slender; posterior tarsi laterally compressed, and hairy on the outside, in the males.

## Family VI.—Glaucopididæ.

Antennæ slender, almost setaceous, or very slightly thickened in the middle, and distinctly bipectinated beneath in the males. Palpi slender, more or less elongated, not pressed to the face. Wings sometimes narrow, and sometimes widened, entire, and for the most part opaque. Abdomen nearly cylindrical, and frequently tufted at the end. Flight diurnal. Larvæ cylindrical, hairy, without a caudal horn.

### Genus XV.—Procris.

Wings narrow, elongated, opaque, and immaculate. Antennæ slender, tapering at each end, and bipectinated beneath in the males. Palpi small, short, pendent, and nearly naked. Tongue short, but distinct, and spirally rolled. Abdomen slender and nearly cylindrical in the males, thicker in the females, and tufted at the end. Spurs of the hind tibiæ two in number, and very minute.

### Genus XVI.—Glaucopis.

Wings narrow in some, broad in others, entire, for the most part opaque, and with the body more or less glossed with blue, sometimes spotted or partially transparent. Antennæ feathered or bipectinated in both sexes, the pectinations elongated in the males, and short in the females. Palpi more or less elongated and recurved. Tongue moderate, spirally rolled. Caudal tuft minute or wanting in the greater number. Posterior tibiæ with three or four spurs of moderate size.

From this Synopsis it will be seen that the divisions and arrangement which I have adopted, differ somewhat from those of the entomologists of the present time. The affinities or resemblances of the Lepidoptera, in their different states, are so various, that it is impossible to preserve a natural connection between them in a linear series. After repeated trials, I have concluded still to adhere to the views of our great masters in Entomology, Linnæus and Fabricius, especially as modern entomologists are by no means agreed upon the limits of the larger divisions of the Lepidoptera, and the order of the genera.

# ORDER LEPIDOPTERA. L.

## SPHINGES. L.

*Crepuscularia.* Latr. *Clostérocères.* Duméril. *Hétérocères.* Boisduval. (Part.)

## Tribe I. SPHINGES LEGITIMÆ. L.

## Family I. SPHINGIADÆ. H. *The Sphingians.*

### § *Alis angulatis.* L.

### Genus I. SMERINTHUS. Latr.

* *Antennæ transversely biciliated beneath in the males.*

1. *S. excæcata.* Smith–Abbot.

Fawn-colored; fore-wings deeply scalloped and toothed on the outer edge, clouded and banded with brown; hind-wings rose-colored in the middle, with a large round eye-like black spot, having a pale blue centre, near the anal angle; fringes narrow, white; thorax with a central lance-shaped chestnut-colored spot, the point of which extends upon the head. Expands two and a half to three inches and a half. *Larva* granulated, apple-green, with two short pale lines before, seven oblique yellowish white lines on each side, and a bluish caudal horn. It feeds upon the leaves of the apple-tree, and upon those of *Rosa Carolina* also, according to Abbot, who (in his Insects of Georgia, p. 49, pl. 25,) has represented a variety of the larva of a yellow color, and greenish at the sides, which are obliquely banded with yellow, and have two longitudinal rows of rust-red spots upon them. It enters the earth to undergo its transformations. *Pupa* chestnut-brown, with a short obtuse anal spine.

2. *S. Astylus.* Drury. = *integerrima.* H. Catalogue Ins. Mass.*

Cinnamon-colored; fore-wings angulated but entire, tinged with rosy white at base, with whitish wavy bands near the tip, a bluish mark along the inner margin, and a tawny yellow spot on each outer angle; hind-wings tawny yellow at base, with a round black eye-like spot, having a pale blue centre, near the anal angle; middle of the thorax cinnamon-red, shoulder-covers paler

* Catalogue of the Insects of Massachusetts, by T. W. Harris; appended to Prof. Hitchcock's Report on the Geology, &c. of Massachusetts.

with a rosy white tinge, and a brown edge above; abdomen with a longitudinal dorsal brown line. Expands from two and a half to two inches and three quarters.

My specimens, a male and a female, were captured at Cambridge on the *Azalea viscosa.*

3. *S. Myops.* Smith–Abbot. = *Rosacearum.* Boisd.

Chocolate-brown; fore-wings sinuated and angulated on the outer edge, varied with wavy whitish and brown bands, with a white Z at tip, and a tawny yellow spot on each of the outer angles; hind-wings with abbreviated whitish and brown bands upon the front edge, ochre-yellow next to the body, with a round black eye-spot having a pale blue centre near the anal angle; head and shoulder-covers glossed with bluish white; a rusty brown stripe in the middle of the thorax; abdomen with a few tawny yellow spots on each side. Expands from two inches and three lines to two inches and six lines. *Larva*, as figured by Abbot, (Ins. Georg. p. 51, pl. 26,) apple-green, the head margined with yellow, and two rows of rust-red spots with six oblique yellowish bands on each side of the body. Abbot says that it eats the leaves of the wild cherry-tree, and buries itself in the ground to undergo its transformations. *Pupa* deep brown.

M. Boisduval has named and figured but has not described this species, in the first volume of his Species Général des Lepidoptères, pl. 15, fig. 4; moreover the name given by him is subsequent to that of Sir J. E. Smith, which is an additional reason why it cannot be adopted.

* * *Antennæ pectinated on both sides in the males.*

4. *S. geminata.* Say.

Rosy ash-gray; fore-wings angulated and with a sinuous outer margin, varied with transverse wavy rosy gray and brown lines, a brown spot and angulated band near the middle, and a deep brown semioval spot at tip; hind-wings rose-colored in the middle, with a large semioval black spot including two pale blue spots near the anal angle; thorax with a large central semioval brown spot. Expands from two and a quarter to more than two inches and a half.

I am indebted to the Rev. L. W. Leonard, of Dublin, N. H., for my specimens, both of which are males. The figure of *S. ocellatus Jamaicensis*, in Drury's Illustrations, Vol. II, pl. 25, fig. 2, 3, very nearly resembles the *geminata*, but it has only one blue pupil in the eye-spot of the hind-wings. Mr. Kirby's *S. Cerisii*,

(Faun. Bor. Amer. IV, p. 301, pl. 4, fig. 4,) is probably identical with Drury's species.

* * * *Antennæ, in the males, with the joints distinct and doubly bipectinated.*

5. *S. Juglandis.* Smith–Abbot.

Rosy gray, drab, or dusky brown; wings indented on the outer edges; fore-wings with a dusky outer margin, a short brownish dash near the middle, and four transverse brown lines converging behind and enclosing a square dark brown spot adjacent to the middle of the inner margin; hind wings with two narrow transverse brown lines between two brownish bands; thorax with a central brown line; abdominal segments plaited and prominent at the sides. Expands from two and a quarter to three inches. The females are much larger and of a lighter brownish gray color than the males, with the square spot on the fore-wings less distinct. *Larva* with the head small, and the body attenuated before and behind, pale blue-green, with a long caudal horn, and seven oblique white bands on each side. When disturbed it makes a creaking noise by rubbing together the joints of the forepart of its body. It eats the leaves of the black walnut, and enters the earth to undergo its transformations. Mr. Abbot (Ins. Georg. p. 57, pl. 29) has figured a remarkable variety of the larva, which is of a crimson color, with the fore-part of the body and the oblique bands yellow. *Pupa* deep chestnut-brown, granulated, with six little tubercles on the head-case, a transverse row of acuminated granules on the hinder edges of the abdominal segments, the last three of which segments are flattened beneath and angularly dilated at the sides, with the tip broad, truncated, and externally bidentate.

The antennæ of the males of this species differ from those of the preceding in having the joints distinct to the naked eye, and each joint furnished with two teeth or short pectinations on each side. Mr. Doubleday presented me with specimens, from Florida, which differ from our northern specimens only in being of a darker color.

* * * * *Antennæ, in the males,* ———.

6. *S. modesta.* H.

Drab-colored; fore-wings scalloped, with a transverse dusky band before the middle; hind-wings purplish-red in the middle, deeper red next to the base, and with a blackish spot near the anal angle. Expands four inches and one quarter.

I have never seen but one specimen, which was much rubbed before it came into my possession. It is a female, with a very thick and robust body, and simple antennæ, and probably is the North American representative of *S. Tiliæ* and *Quercus*.

§ *Alis integris, ano simplici.* L.

## Genus II. Ceratomia. H.

I have been induced to propose a new genus for the reception of a single species, presenting characters, in the larva and winged state, which do not allow it to be included in the genus Sphinx as now received. The larva of this species, in the possession of horns on the fore-part of the body, exhibits a peculiarity which hitherto appears to have been unnoticed or undescribed among the Sphinges. The name of the genus, derived from *κέρατα, horns*, and *ὠμία, the shoulder*, alludes to this peculiarity. An analogous and still more imposing form is found in the larvæ of the *Phalænæ*, belonging to the genus *Ceratocampa*.

*C. quadricornis.* H.

Light brown; fore-wings with zigzag and wavy brown and whitish bands, dusky in the middle to the inner margin, the anterior edge whitish, and a large white dot near the middle; hind-wings with three dusky transverse bands, and a broad blackish hind-border; fringes dotted with white; head and a broad line on each side of the thorax to the shoulders white; shoulder-covers with three and abdomen with five longitudinal brown lines. Expands four and a half to nearly five inches. *Larva* pale blue-green, longitudinally wrinkled, with a pair of short denticulated horns on the second segment, a similar pair on the third, two parallel series of little teeth on the first four segments, a dorsal row of larger teeth extending to the tail, a long bluish caudal horn, and seven narrow oblique white lines on each side of the body. It feeds upon the leaves of *Ulmus Americana*, and transforms in the earth.

## Genus III. Sphinx. L.

* *Tongue-case of the pupa detached from the breast.*

1. *S. cingulata.* F. = *Convolvuli.* Smith–Abbot.

Dark ash-gray, variegated with brown, body beneath white; middle of the hind-wings pink, with three or four black bands; fringes of the wings spotted with white; and five pink-colored spots separated by short transverse black lines on each side of

the abdomen. Expands about four inches. Larva, as represented by Abbot, (Ins. Geog. p. 63, pl. 32) dark brown, with a double chain-like rust-red dorsal line, a paler lateral line, a series of eight hook-shaped yellowish spots on each side enclosing the spiracles, and a short curved horn on the tail. Eats the leaves of the sweet potato (*Convolvulus batatas*,) and enters the earth to undergo its transformation. *Pupa* with a long hooked tongue-case spirally recurved at its extremity. Inhabits the Middle and Southern States.

I am indebted to Dr. J. E. Holbrook, of Charleston, S. C., for a specimen.

2. *S. Carolina.* L.

Ash-gray; fore-wings with blackish wavy lines; hind-wings whitish in the middle, with four black bands, the two central ones narrow and jagged; fringes spotted with white; five orange-colored spots encircled with black on each side of the abdomen; and the tongue excessively long. Expands about five inches. *Larva* apple-green, transversely wrinkled, with seven oblique white lines on each side, and a rust-colored caudal horn. Commonly known by the names of *potato-worm* and *tobacco-worm*, from the plants on which it is found; transforms deep in the earth. *Pupa* with a long tongue-case, curved near the head, straight and touching the breast only at the end, representing the handle of a vase.

3. *S. Drupiferarum.* Smith–Abbot.

Pale reddish-gray; fore-wings with a dark brown band extending from the inner margin to the tip, and crossed by slender black lines between the nervures;* hind-wings with two transverse blackish bands; thorax dark chestnut, with the sides and the head white; abdomen dark brown above, with a slender dorsal black line and about five whitish lateral spots margined with black. Expands three and a half to four inches. *Larva*, according to Abbot, (Ins. Geog. p. 71, pl. 36) apple-green, with seven oblique lateral bands, which are violet above and white below, a line on each side of the head and the caudal horn violet. Feeds on the leaves of the *Celtis* and plum, and is transformed in the earth. *Pupa*, like that of *S. Ligustri*, with a short tongue-case detached from the breast.

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* The veins, or elevated and branching lines on the wings of insects, are called *nervures* by Mr. Kirby.

4. *S. Kalmiæ.* Smith–Abbot.

Rusty-buff; fore-wings streaked with light brown, and with a narrow whitish band near the outer margin; hind-wings with a narrow central and a broad marginal blackish band; fringes brown spotted with white; shoulder-covers white edged with brown; abdomen with a slender dorsal black line and short transverse bands alternately black and white at the sides; beneath dull reddish white. Expands three and a half to four and a quarter inches. *Larva*, according to Abbot, (Ins. Georg. p. 73, pl. 37) pale green, with seven oblique yellow bands, edged above with violet, on each side, the caudal horn and a line on each side of the head blue, and the hinder pair of legs yellow. Feeds on the leaves of *Kalmia latifolia*, and transforms in the earth. *Pupa* with a short detached tongue-case.

5. *S. Gordius.* Cramer.

Brownish ash-gray; fore-wings streaked with black between the nervures, with the anterior and inner margin dusky-brown, a white dot near the middle, and a large gray spot at base; fringe spotted with white; hind-wings with a narrow central and a broad marginal dusky brown band, and a white fringe; thorax deep chestnut, with the sides and the head above whitish; abdomen with a central black line, and the sides ash-white transversely banded with black. Expands three to three inches and a half. *Larva* apple-green, with seven oblique white lateral bands, slightly edged above with violet, a rust-red caudal horn, and a brownish line on each side of the head. It lives on the apple-tree, and enters the earth to be transformed. *Pupa* with a very short detached tongue-case.

6. *S. cinerea.* H.

Ash-gray; fore-wings long, narrow, and entire, with five short oblique lines between the nervures; hind-wings with two blackish bands; shoulder-covers slightly edged with black above; abdomen with a narrow dorsal black line, and short alternate bands of black and dirty white on the sides. Expands four and a half to five inches and a quarter.

The specimens from which this description is taken were raised many years ago from larvæ, which, at the time, I neglected to figure and describe. To the best of my recollection, these larvæ were found on the lilac, and, with the pupæ, corresponded very nearly in form, color, and size, to those of the European *S.*

*Ligustri.* The present species is remarkable for the length and sharpness of the wings, which are of a fine neutral gray tint, and for the prominence of the head and palpi.

* * *Tongue-case of the pupa not detached, but buried, and soldered to the breast.*

7. *S. sordida.* H.

Dark gray; fore-wings variegated with dark brown, dashed with a few blackish lines, and with a whitish dot near the middle; hind-wings with a blackish basal spot, and two broad black bands; a dark brown line on each shoulder-cover; abdomen with a dorsal black line, and alternate black and light gray bands on the sides. Expands two inches and three quarters.

Although the larva and pupa of this species are unknown to me, I judge from analogy that it belongs to this division of the genus Sphinx.

8. *S. Hylæus.* Drury.=*Prini.* Smith–Abbot.

Rusty brown; fore-wings mottled with white, banded with jagged dark brown lines, with a white dot near the middle, and a spot of the same color at tip; hind-wings whitish with a narrow indented brown band across the middle, and a broad one on the outer margin; fringes spotted with white; a whitish line above the eyes extending on each side of the thorax; two longitudinal rows of white dots on the top of the abdomen, and a series of short narrow white bands on each side. Expands two and a quarter to two inches and three quarters. *Larva* pea-green, with six or seven oblique lateral whitish bands edged above with pink, a purple caudal horn, and a pale blue line on each side of the head. It feeds on the leaves of *Prinos glaber* and various species of *Vaccinium*, and enters the earth to be transformed.

This insect is much like the *Brontes* of Drury, which, however, is a much larger species, more distinctly banded with white, &c.

9. *S. Plebeja.* F.

Gray; fore-wings with a white dot near the middle, and five or six short oblique blackish lines between the nervures; hind-wings sooty black, dirty white at base; fringes white, spotted with dark brown; abdomen with three black lines, one dorsal, and two on each side, the latter enclosing a longitudinal series of dirty white spots. Expands three inches. Inhabits the Southern States.

The only specimen which I have seen was taken by Prof. Hentz in North Carolina, and now belongs to the Boston Society of Natural History.

10. *S. Coniferarum.* Smith–Abbot.

Gray; fore-wings with about three narrow and indented brownish bands, a spot near the middle, one or two streaks beyond the middle, and the nervures near the outer margin brown; hind-wings dusky or blackish gradually fading into gray towards the base; fringes spotted with brown and white; abdomen gray with brownish incisures. Expands one inch and three quarters to two inches and three quarters. *Larva*, as figured by Abbot, (Ins. Georg. p. 83, pl. 42,) chequered with brown and white spots, with a dorsal whitish line, and a short caudal horn. It eats the leaves of various kinds of pine, and enters the earth to transform. Mr. Leonard informs me that the tongue-case of the *Pupa* is short, and buried so as not to rise above the leg-cases.

For my specimen I am indebted to the Rev. L. W. Leonard, who raised it from a larva found on the pine in Burlington, Vt. In the cabinet of the Boston Society of Natural History there is a larger specimen, which was taken in North Carolina by Prof. Hentz; the bands on the wings in the latter are less distinct than in my specimen.

11. *S. Ello.* L.

Gray; fore-wings slightly indented on the outer margin, with a few irregularly scattered black dots, and a blackish stripe extending from the base to the tip; hind-wings rust-red, with a broad black hind-border; thorax with five longitudinal black lines, and abdomen on each side banded with black. In the female the blackish stripe on the fore-wings and the lines on the thorax are usually wanting or indistinct. Expands three and a quarter to four inches. Inhabits the Southern States, the West Indies, and South America.

In the cabinet of the Boston Society of Natural History there is a specimen of this tropical insect, which was captured by Prof. Hentz in the interior of North Carolina, where eventually the species may become common. According to Madam Merian (Insectes de Surinam, page and plate 61) the *larva*, in Surinam, lives on the leaves of a species of *Psidium* or Guava, is of an obscure brown color, with a black dorsal line, some small irregular white spots on the sides, and the head and caudal horn purple.

The tongue-case of the *pupa*, from the figure, seems to be short and soldered to the breast. From the shape of its body and wings, this insect must belong to a very distinct group in the Linnean genus Sphinx; but, without knowing more of the larva and its transformations, I do not feel authorized to separate it from the present genus.

## Genus IV. Philampelus. H.

The insects belonging to this genus cannot with propriety be included in the genus *Chærocampa* of Duponchel, or *Metopsilus* of Duncan, to which they approach the nearest; and, therefore, I have considered it proper to institute a new genus for their reception. They, indeed, seem to form a characteristic and typical group, peculiar to the New World, being found only in the United States, Mexico, the West Indies, and the tropical parts of South America. The larvæ feed chiefly on the vine and the plants allied to it, which suggested the name of the genus, derived from φιλεω, *I love*, and ἄμπελος, *a grape-vine*. In those species whose transformations have passed under my own observation, the larvæ when young were furnished with a long slender caudal horn, recurved over the back like the tail of a dog; when about half grown, the caudal horn is shed with the skin, and is replaced by a prominent, eye-like, polished spot. The oblique spots on the sides of these larvæ slope downwards and backwards; this is also the direction of the bands in the larvæ of *Pterogon;* but in those of all the other *Sphinges* the oblique lateral bands slope upwards and backwards. The *pupa* is elongated, attenuated at the fore-part, with a pretty long, robust, rough, anal horn, notched at the tip; the tongue-case is buried and soldered to the breast, and slightly longer than the wing-case's; and the fore-part of the abdominal rings is roughened with deep punctures. In the perfect state, the fore-wings are entire, acute, slightly emarginated below the tip in the males, and almost falcated, with a sinous inner margin, and well-marked hind-angle; the outer margin of the hind-wings is undulated or slightly crenated; the shoulder-covers are large; and the abdomen is short, thick, conical, and usually immaculate. Madame Merian in her Insectes de Surinam, plates 34 and 47, has represented the transformations of three species of this genus; and two are also figured by Mr. Abbot in the Insects of Georgia, plates 40 and 41.

1. *P. Vitis.* L.

Grayish flesh-colored; fore-wings, except the anterior and outer margins, dark olive, with a broad stripe from base to tip, crossed by another from the middle of the inner margin, a small hook-shaped spot near the middle, and the nervures behind, of a pale flesh-color; hind-wings pale green at base, with the inner and hinder margins rose-red, a black spot near the middle and a black transverse band behind; a longitudinal line on the head and thorax, the shoulder-covers, two broad stripes on the abdomen, and a round spot on each side of its base of a dark olive color. Expands about four inches. Larva, as represented by Abbot, (Ins. Georg. p. 79, pl. 40,) pale pea-green, longitudinally striped on the top of the back and transversely at the sides with brown, and with seven oval, oblique, cream-colored spots on each side. According to Linnæus and Mad. Merian, it lives on the grape-vine; but Mr. Abbot has represented it upon *Jussiæa erecta.* Inhabits the Southern States, South America, &c.

This insect fades very much by age, which changes the flesh-colored portions to a pale reddish buff or nankin color. My specimens were received from Dr. J. E. Holbrook, of Charleston, S. Carolina.*

2. *P. Satellitia.* L. = *Licaon?* Cramer.

Light olive, variegated with dark olive; fore-wings with an abbreviated band beyond the middle, an oblong patch on the basal half of the hind margin including a square darker spot, a semi-oval spot near the tip, and a triangular one near the hind angle, of a dark olive color, and two approximated brownish dots near the middle; hind-wings with a black spot near the middle of the inner margin, and a transverse blackish band behind, obsolete near the anal angle and ending there in a few small black spots;

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* I have received from Dr. H. B. Hornbeck, King's physician, in the island of St. Thomas, W. I., a species which is closely allied to *P. Vitis;* and, as it is not described in any of my books, I am happy to describe it here under the name of

*P. Hornbeckiana.*

Above olive gray; fore-wings dark olive, with two silvery white stripes crossing each other in the middle of the wing, the longest stripe toothed near the base of the wing and obsolete thence to the middle, three of the nervures and a band on the outer margin whitish, and two approximated black dots near the middle; hind-wings on the inner margin pink, with a large square olive-colored spot, dusky behind with a black transverse band; an olive-colored line on the head and thorax; the shoulder-covers and first segment of the abdomen olive, bordered with white; upper part of the abdomen olive, with a central gray line; outer sides of the legs and antennæ white. Expands about four inches. Inhabits St. Thomas, W. I.

a slender line on the head and thorax, the shoulder-covers, and a transverse patch on the top of the first abdominal segment, dark olive. Expands from four to four inches and three quarters. *Larva*, when young, pea-green, with a slender recurved caudal horn, and of the same color or of a clear light brown and without a tail afterwards, with six oblique broad oval cream-colored spots on each side of the body; feeds on the leaves of indigenous and exotic grape-vines, and on those of *Ampelopsis hederacea*, and enters the earth to transform.

3. *P. Achemon.* Drury. = *Crantor?* F.

Red-ash colored; fore-wings with a few short transverse brown lines, and shaded with brown from the middle to the hind margin, with a square spot near the middle of the inner margin, another near the tip, and a triangular spot near the hind angle, of a deep brown color; hind-wings pink, with a deeper red spot near the inner margin, a dusky hind border, and a transverse row of small black spots; palpi and a large triangular spot on each shoulder-cover deep brown. Expands from three to four inches. *Larva* pea-green with a slender recurved tail when young, of the same color or light brown and without a tail subsequently, with six oblique oblong oval scalloped cream-colored spots on each side. It eats the leaves of grape-vines and of the common creeper or *Ampelopsis.*

This and the preceding species, in the larva state, are very injurious to our cultivated grape-vines.

## Genus V. Chœrocampa. Duponchel.

*Metopsilus.* Duncan. *Deilephila.* (section.) Boisduval.

This genus was established, in 1835, by M. Duponchel,* to receive certain European Sphinges the larvæ of which have the head and fore-part of the body retractile, the head being very small, and the first three segments abruptly diminishing in size from the fourth, which gives to the fore-part of the body a resemblance to the head and snout of a hog. Hence the French name of these larvæ, *cochonnes*, and the generical name proposed by Duponchel, which is derived from χοῖρος, *a hog*, and κάμπη, *a caterpillar*. This peculiarity in the form of the larvæ seems to have suggested to Linnæus the names that he has given to two

* Godart and Duponchel. Lepidoptères de France. Supplément. Tome II, p. 159. (1835.)

of the species, to wit, *porcellus*, *the pig*, and *Elpenor*, the name of one of the companions of Ulysses, who was changed to a hog by Circe. In the year 1836, Mr. Duncan,* probably not aware of the previous establishment of this genus, pointed out its characters under the name of *Metopsilus*, derived from *μέτωπον*, *the front*, and *ψιλὸς*, *slender*, in allusion to the form of this part of the larva. These naturalists, in separating this new group from the genus *Sphinx*, or rather from *Deilephila*, seem to have had only European insects under consideration; but in America there are several species, which, so far as similarity of form and habits, in all their states, indicates a natural affinity, ought certainly to be included in the same generical group, from which, however, they will be excluded unless the characters of the genus are somewhat modified to receive them. Believing the genus to be a good one, and susceptible of modification, I have changed the characters of it in the synopsis prefixed to this catalogue, so as to admit our American species. In *C. Pampinatrix*, *Chærilus*, and *versicolor*, the antennæ are rather short and slender, arcuated, and end in a very long slender hook; the fore-wings have the outer and inner margins sinuous, so as to exhibit prominent outer and hinder angles; the hind-wings have a sinuous hind-margin, and a prominent angle near the tail; and the abdomen is rather short, and conical at tip. The *larvæ* of the first two of these species have the eleventh segment conically prolonged above, forming a base for a very short slightly curved caudal horn, and the sides of the body are marked with oblique bands sloping upwards and backwards. They transform above ground, under fallen leaves, or slightly covered with grains of earth, connected by a few threads, so as to form a loose imperfect cocoon. The pupa is short, thick, obtusely rounded before, with the tongue-case imbedded, indistinct, and nearly as long as the wing-cases; the tail is rather blunt, and ends in a long, slender point, which, under a magnifier, is found to be rough, and notched at the tip.

1. *C. Pampinatrix.* Smith–Abbot.

Light olive-gray above, shaded with olive; fore-wings with a dot near the middle, a transverse band near the base, a broader band beyond the middle and a large triangular spot adjacent to each acute angle and almost forming a third band, of an olive color; hind-wings rust-colored, dusky behind, and gray next the

* Jardine's Naturalist's Library. Entomology. Vol. iv, p. 154. (1836.)

anal angle; head and shoulder-covers dark olive; and a white line on each side of the thorax at the origin of the wings. Expands two and a half to two inches and three quarters. *Larva* pale green, with a longitudinal series of six triangular orange-colored spots on the top of the back and a darker green lateral line; sides below this paler, almost white, sprinkled with rusty dots, and with six oblique green bands; caudal horn short, bluish green. It varies in being of a clear light brown color, with the back bounded on each side by a darker longitudinal line, meeting at the origin of the caudal horn, the sides tinged with pink, and obliquely banded with brown. Feeds on the leaves of the grape-vine. *Pupa* clay-colored, sprinkled and punctured with black, and with the incisures of the abdomen black.

Mr. Abbot, on plate 28 of his Insects of Georgia, has represented this larva with the caudal horn too long and too much curved, and the eleventh segment not so much produced behind as it ought to be. This species, in the winged state, comes very near to Cramer's *Sphinx Myron*, which, from the figure, seems to want the spot in the middle of the fore-wings, and, according to Cramer, has a very short tongue, a character that does not apply to the *Pampinatrix*. The larva, above described, is one of the most injurious to our cultivated grape-vines; for, not satisfied with devouring the leaves, it nips off the fruit-stalks when the grapes are not more than half grown. I have gathered under a single grape-vine above a quart of unripe grapes which had been detached thus during one night by these larvæ.

2. *C. Chærilus.* Cramer. = *Azaleæ.* Smith–Abbot.

Rust-colored; fore-wings rusty gray tinged with blue, with a dot near the middle, a few spots between it and the base, and a very broad band beyond the middle, rust-colored; hind-wings rust-colored, dusky near the anal angle, with a whitish fringe; a spot at the sides and a slender line on the top of the thorax, the edges of the shoulder-covers and of the abdominal segments white. In the male the broad band of the fore-wings is marked by a pale and a dark zigzag line so as nearly to divide it into two bands. Expands two and a half to three inches. *Larva*, as represented by Abbot, (Ins. Georg. p. 53, pl. 27,) varying in color, being either pale green, with a narrow dusky dorsal line, a greenish line on each side, a blue-green caudal horn, and the sides obliquely banded with green; or clear pale red, with the lines and bands brownish, and the horn chestnut-colored. Mr. Abbot

says that it lives on *Azalea nudiflora*, and that it spins itself up in a thin web on the leaves. *Pupa* like that of *C. Pampinatrix.*

3. *C. versicolor.* H.

Light olive, variegated with olive-green and white; fore-wings with narrow curved bands of white and olive-green, and a zigzag white line at tip; hind-wings rust-colored, with the inner and hind margin olive-green; tips of the palpi, a line on each side of the head above the eyes, a longitudinal dorsal line from the front to the tail, and the edges of the collar and of the shoulder-covers, white; two spots on the metathorax and the abdominal segments on each side of the dorsal line tinged with dark buff. Expands about three inches.

Although the larva and pupa of this species are unknown to me, I have ventured to place it in the genus *Chærocampa.* The palpi are rather thicker towards the tip than those of the two preceding species; the fore-wings are not quite so much emarginated, and consequently, their angles are not quite so prominent. The under-side is quite as prettily variegated as the upper-side; that of the fore-wings being pale olive, tinged with deep buff near the hind-angle, with rust-red in the middle, and mottled and streaked with olive-green and white; that of the hind-wings olive-green, banded with white, dark olive, and buff. My specimen was taken sitting upon the leaves of *Azalea viscosa;* it was quite fresh, and seemed to have been recently transformed.

Dr. Hornbeck has presented to me a species, from St. Thomas, resembling the *versicolor* very nearly in color and form; but the palpi are more prominent, the antennæ are not so much arcuated, and the terminal hook is much shorter. It evidently leads to the genus *Deilephila.*

4. *C. tersa.* L.

Grayish olive above; fore-wings streaked from base to tip with numerous narrow dusky and pale lines, and with a minute black dot near the middle; hind-wings black, paler round the edges, with the anal angle and the fringe cream-colored, and a transverse row of small wedge-shaped cream-colored spots near the hind-margin; a reddish white line on the sides of the head and thorax; shoulder-covers slightly edged above with rust-red; sides of the abdomen, and the body and wings beneath, rusty buff, streaked and sprinkled with dusky olive-gray. Expands two and three quarters to three inches. *Larva*, according to Abbot, (Ins. Georg. p. 75, pl. 38,) pea-green or brown, with seven white eye-

like spots having a red centre and a black margin and connected by a longitudinal white line, on each side of the body, and a red caudal horn. It lives on *Spermacocce Hyssopifolia*, and, like the other species, is transformed in an imperfect cocoon which it spins above ground. *Pupa* clay-colored, freckled with dusky spots. It inhabits the Southern States, the West Indies, and South America.

I am indebted to Dr. J. E. Holbrook of Charleston, S. C., and to Dr. H. B. Hornbeck, of St. Thomas, W. I., for specimens. The antennæ are straight, with a shorter terminal hook than in the three preceding species; the outer margin of the fore-wings is not so sinuous, and the abdomen is much more elongated, slender and pointed. It may be necessary, hereafter, to institute a new genus for the reception of this and several other closely allied West-Indian and South-American species.

## Genus VI. Deilephila. Ochsenheimer.

1. *D. lineata.* F. = *Daucus.* Cramer.

Olive-brown; fore-wings with a pale buff-colored stripe from the base of the inner margin to the tip, crossed by six white lines on the nervures, the outer margin ash-gray, the fringe and edge of the inner margin white; hind-wings rose-pink, with a white spot near the inner margin, a black band at base, another near the hind-margin, and the fringe, white; a white line on each side of the head above the eyes, and six lines, of the same color, placed in pairs, on the thorax; two rows of small black spots and a slender dorsal white line on the top of the abdomen, the sides reddish, with a short transverse black band on each side of the first abdominal segment, and a white band behind it, followed by a lateral series of alternately black and white spots. Expands from three to four inches. *Larva* pea-green, with a longitudinal series of nine or ten orange-colored oval spots encircled with black, on each side, and an orange-colored caudal horn. Feeds upon the leaves of the purslane and turnip, and of various other humble plants, and buries itself in the ground to undergo its transformations. *Pupa* light brown.

Contrary to what is usual among our Sphinges, there are two broods of this species in the course of one summer. This is the true *Sphinx lineata* of Fabricius, described by him as an American insect in his "Systema Entomologiæ." His description of the thorax, "*striis tribus albis duplicatis*," applies exactly to our insect, and not to the *Livornica* of Europe, with which it is often

confounded, and which has only four white lines instead of six, on the thorax. The larva of the latter, moreover, differs from that of our *lineata*. Dr. Hornbeck has sent to me from St. Thomas, W. I., specimens which vary a little, but are not specifically distinct from the *lineata* of the United States.

2. *D. Chamænerii.* H. = *Epilobii.* H. (Catalogue.)

Olive-brown; fore-wings with a sinuous buff-colored stripe, indented before, beginning near the base of the inner margin and extending to the tip, and a dark olive-brown tapering stripe behind it, a black spot at base, a white dash and a diamond-shaped blackish spot before the middle; hind-wings dark brown, with a transverse rose-colored band, including a white spot near the body and a deep red one before the anal angle; inner edge of the fore-wings and fringe of the hind-wings whitish; palpi white below; a white line above each eye extending on the sides of the thorax, where it is bounded above by a black line; abdomen with a dorsal series of white dots, two black and two alternating white bands on each side of the base, and two narrow transverse white lateral lines near the tip; segments beneath edged with white. Expands from two and three quarters to three inches. *Larva* green, somewhat bronzed, dull red beneath; with nine round cream-colored spots, encircled with black, on each side, and a dull red caudal horn. It lives on the *Epilobium angustifolium*, and (as Mr. Leonard informs me) transforms in the ground, without making a cocoon. Inhabits New Hampshire.

The larva very closely resembles that of *D. Galii*, as figured by Roesel, III, Tab. VI, Fig. 1, 2. For a specimen of it, and for the insects in the winged state, I am indebted to Mr. Leonard, by whom they were raised. This species is the American representative of *D. Galii*, and is also allied to several other European species, such as *D. Epilobii*, *Esulæ*, *Amelia*, *Tithymali*, *Dahlii*, *Euphorbiæ*, &c.; but I am satisfied that it is perfectly distinct from all of them; and the long description which I have given of it will render it easy to discover in what respects it differs from them. Moreover it is a legitimate species, which is more than can be said of all of the above-named European insects, some of which are now admitted to be hybrids. Mr. Kirby (Fauna Boreali-Americana, IV, p. 302,) describes a North American species, under the name of *D. intermedia*, which, according to him, has the stripe on the fore-wings of a pale rose color, and wants the

dorsal series of white dots on the abdomen; in other respects it seems nearly allied to the *Chamænerii*. When my Catalogues of the Insects of Massachusetts were published I was not aware that the specific name *Epilobii* had been previously appropriated; for the species to which I then applied it I have now substituted that of *Chamænerii* derived from Tournefort's name for the genus *Epilobium*.

§ *Legitimæ —— ano barbato.* L.

## Family II. MACROGLOSSIADÆ. H. *The Macroglossians.*

*Sesiidæ.* Stephens. *Sesiadæ.* Kirby.

* *Wings angulated and indented; antennæ tapering at the end, with a long terminal hook.*

### Genus VII. Pterogon. Boisduval.

*P? inscriptum.* H.

Ash-gray; wings angularly indented; first pair with two dusky bands near the base, connected on the inner margin by a blackish line, a few undulated and zigzag transverse lines beyond the middle, a dusky outer margin, a half-oval brown spot at tip, and a small deep brown patch including a white I near the tip; hind-wings reddish gray, with a dusky hind-margin; collar edged with brown; abdomen with two dorsal series of black dots. Expands two inches. Inhabits Indiana.

Of this species I have seen only two individuals, both females, having rather long slender and simple antennæ, attenuated and curved so as to form a hook at the end. In the shape of the wings and distribution of the colors this insect nearly resembles some species of *Smerinthus*, from which genus it is excluded by the length of the tongue, which nearly equals that of the body. *Pterogon Gauræ*, which I suppose to be the only legitimate species of the genus that has yet been discovered in the United States, is known to me only by Mr. Abbot's figure.

### Genus VIII. Thyreus. Swainson.

1. *T. lugubris.* L.

Brown; wings sinuated and slightly angulated on the outer edge; first pair with an oblique streak and an eye-like dot before

the middle, and a large triangular brown patch near the tip; hind-wings with two or three obscure transverse brown lines; male with a triple-tufted tail. Expands two and a half to three inches. Inhabits the Southern States. *Larva* pale green, with three darker longitudinal dorsal lines, nine oblique yellowish bands on each side, and a long, slender, nearly straight caudal horn. Mr. Abbot, from whose figure (Ins. Geog. p. 59, pl. 30) this description of the larva is taken, says that it feeds on Virginian creeper, *Ampelopsis Hederacea*, and that it enters the earth to transform. The *pupa* is elongated, chestnut-brown, with a short anal point.

My specimen of this insect was presented to me by Dr. J. E. Holbrook. It is closely allied to several South American species, figured by Cramer, such as his *Fegeus*, *Gorgon*, &c.; and, indeed, the *Fegeus* may prove to be identical with it.

M. Boisduval (Icones Hist. des Lépidoptères d'Europe nouveaux, Vol. II, p. 15) refers the *Gorgon* of Cramer [?] to his genus *Pterogon*; but, in my opinion, the genus *Thyreus* of Swainson, besides having the priority in point of time, is entitled to rank as a distinct genus. Is the European *Gorgon* of Esper, Hübner, and Ochsenheimer, quoted in Mr. Children's Abstract of the Characters of Ochsenheimer's Genera (Philos. Mag. N. S. Vol. V, p. 37), the same as the Surinam species named *Gorgon* by Cramer? And if not, is M. Boisduval's citation of Cramer's name correct?

2. *T. Abbotii.* = *Abbottii.* Swainson.

Chocolate-brown; wings very much indented on the outer edge; first pair with wavy and oblique blackish brown streaks, and a black dot near the middle; hind-wings yellow, with a broad blackish brown hind-border; edge of the collar and a transverse stripe across the thorax black; abdomen banded with black at base, tufted at the sides of the hinder segments, and terminated by a triple-tufted rust-colored tail. Expands from two and one third to nearly three inches. *Larva*, as figured by Abbot, (Swainson's Zoological Illustrations, Part I, pl. 60) pea-green, with narrow dorsal brown lines, nine lateral oblique yellowish bands broadly bordered above with brown, and a long slender slightly curved caudal horn. It feeds on the grape-vine. *Pupa* chestnut-brown, with two yellowish abdominal incisures.

This species is not uncommon in the Southern States, and I have one specimen which was taken in Cambridge, Mass.

3. *T? Nessus.* Cramer.

Dark brown; fore-wings with a sinuous and angular outer edge, a blackish brown band across the middle, another near the outer margin, and a small rust-red spot near the tip; hind-wings rust-red, with a dark brown hind-border; abdomen with two pale yellow bands behind the middle, four rust-red spots on each side, and a triple-tufted tail. Expands from two to two inches and a quarter.

Of this species I have seen only females, in which the antennæ are similar to those of the same sex in *T. Abbotii.* The palpi, however, are more acuminated, and approach in form to those of *Sesia Pelasgus*, &c. It ought, perhaps, to be included in a new genus, which, without a knowledge of the larva and pupa, I shall not venture to propose.

* * *Wings entire; antennæ thickened towards the end, with a minute terminal hook.*

## Genus IX. Sesia. F. (Syst. Gloss.)

1. *S. Pelasgus.* Cramer.

Wings transparent and iridescent, with a broad purple-brown border and nervures; antennæ and palpi, above, blue-black; head and thorax olive; breast and legs cream-white; abdomen purple-brown below, ochre-yellow above, with the two middle segments and a spot behind them purple-brown, and three lateral white spots; tip with a central fan-shaped brown tail, and two black tufts on each side of it. Expands from two to two inches and one quarter.

2. *P. diffinis.* Boisduval. = *fuciformis.* Smith–Abbot.

Wings transparent and iridescent, with a narrow blackish border and nervures, and a rust-red spot at tip; antennæ and palpi black above; thorax and breast covered with pale yellow hairs; abdomen black above, with two longitudinal patches of yellow hairs, the two middle segments black, the next two covered with yellow hairs, and the tip with a fan-shaped tail, which is yellow in the middle and tufted with black on each side. Expands from one inch and three quarters to two inches. *Larva,* according to Abbot, (Ins. Georg. p. 85, pl. 43.) pale pea-green, reddish beneath, with a longitudinal dorsal line, a lateral pale yellow stripe, and a

short recurved caudal horn. In Georgia, it feeds upon the *Tabernæmontana Amsonia*, and forms an imperfect cocoon on the surface of the ground. *Pupa* brown with the abdominal incisures ochre-yellow.

My specimens were presented to me by Mr. Leonard, who captured them in New Hampshire, where the *Tabernæmontana* does not grow. The larva must, therefore, be sought upon some other plant; perhaps it may be found upon the *Apocynum.* M. Boisduval has named and given a figure of this species in his Hist. Nat. des Insectes Lépidoptères, Vol. I, pl. 15, fig. 2; and, as it is evidently distinct from the European *fuciformis*, I have retained the name proposed by M. Boisduval, although he has not established a claim to it by any description of the insect. Mr. Kirby's *S. ruficaudis* (Faun. Bor. Amer. IV, p. 303,) is evidently different from this species, and comes nearer to the *Pelasgus*, to which, however, the description does not very well apply, in many respects.

## Family III. ÆGERIADÆ. H. *The Ægerians.*

### Genus X. Trochilium. (Scop.) Stephens.

*Sesia.* F. (Entom. Syst.) Latr. Boisd. *Ægeria.* F. (Syst. Glossat.)

1. *T. marginatum.* H.

Black; wings transparent; first pair with a broad border, the tip, and a transverse band beyond the middle pale brown; hindwings with a broad black fringe; antennæ black; two longitudinal lines on the thorax, hind margins of the abdominal segments, orbits, palpi, and legs, except at base, yellow. Expands rather more than one inch and a quarter.

This insect was taken in New-Hampshire, and presented to me by the Rev. L. W. Leonard.

2. *T. tibiale.* H.

Brownish; wings transparent; first pair with a narrow border and an abbreviated band beyond the middle pale brown; hindwings with a narrow brownish fringe; antennæ black; orbits, two lines on the thorax, edges of the abdominal segments, and tibiæ yellow; hindmost tibiæ thickly covered with yellow hairs. Expands one inch and a half. The yellow bands on the abdomen are much narrower and less bright than in the *marginatum.*

Found in New-Hampshire on the *Populus candicans*, and presented to me by Mr. Leonard.

3. *T. denudatum.*

Chestnut-brown; fore-wings opaque, with a large triangular transparent spot adjacent to the outer hind-angle, a rust-red spot at base and another near the middle; hind-wings transparent, with the margin and fringe brown, and a rust-red costal spot; orbits, edges of the collar, incisures of the abdomen, tibiæ, and tarsi dull yellow; antennæ brownish above, rust-yellow at tip and beneath. Expands from one inch and a quarter to more than one inch and a half. The transparent spots at the tips of the fore-wings have the appearance of being caused by the removal of the colored scales.

The specimens, from which the descriptions of these three species are drawn up, had become somewhat oily, and it is possible that some of their characteristic markings may have become obliterated.

## Genus XI. Ægeria. F. (Syst. Glossat.)

*Sesia.* F. (Entom. Syst.) Latr. Boisd. *Trochilium.* Scopoli.

1. *Æ. tricincta.* H. (Catalogue.)

Blue-black; fore-wings opaque; hind-wings transparent, with the border, fringe, and a short transverse line near the middle black; palpi at tip, collar, a spot on each shoulder, and three bands on the abdomen yellow; antennæ short, black; four posterior tibiæ banded with orange; tarsi yellow, tipped with black; tail flat, with two longitudinal yellow lines. Expands from one inch to one inch and two lines.

This species seems to come near to the European *Asiliformis;* but the male has only three yellow abdominal bands; while in the *Asiliformis* there are five bands in the male sex. The antennæ are shorter and thicker than in the following species, and are furnished beneath with a double row of short pectinations or teeth, which are thickly fringed with hairs. The sexes were captured together upon the common tansy.

2. *Æ. Cucurbitæ.* H. (New-England Farmer.)

Fore-wings opaque, lustrous olive-brown; hind-wings transparent, with the margin and fringe brown; antennæ greenish black; palpi pale yellow, with a little black tuft near the tip; thorax olive; abdomen deep orange, with a transverse basal black band, and a longitudinal row of five or six black spots; tibiæ and tarsi of the hind-legs thickly fringed on the inside with black, and on

the outside with long orange-colored hairs; spurs covered with white hairs. Expands from thirteen to fifteen lines. *Larva*, similar in form and color to those of other species of the genus, lives in the pith of squash and pumpkin vines, which it leaves at the root, and forms in the ground a cocoon composed of grains of earth cemented by a gummy matter. *Pupa*, by the aid of the abdominal denticulations, almost entirely excluded from the cocoon during the last transformation.

The sudden death of the squash-vines, during midsummer, is occasioned by the ravages of the larva of this insect. For further particulars relating to it, a communication, by the author, in the New-England Farmer, Vol. VIII, p. 33, for 1828, may be consulted. This species seems to be closely allied to, but sufficiently distinct from the *tibialis* of Drury, and the *Bombiliformis* of Cramer.

3. *Æ. caudata.* H. = *fulvicornis.* H.* (Catalogue.)

Brown; *male* with the fore-wings transparent from the base to the middle; hind-wings transparent, with a brownish border, fringe, and subcostal spot; antennæ, palpi, collar, and tarsi tawny yellow; hind-legs yellow, end of the tibiæ and first tarsal joint fringed with tawny yellow and black hairs; tail slender, cylindrical, nearly as long as the body, tawny yellow, with a little black tuft on each side at base. The *female* differs from the male in having the fore-wings entirely opaque; the hind-legs black, with a rusty spot in the middle of the tibiæ, and fringed with black; caudal tuft of the ordinary form and size. Expands from one inch to one inch and three lines. *Larva* inhabits the stems of our indigenous currant, *Ribes Floridum.*

The *Zygæna caudata*, of Fabricius, has a somewhat similar tail, but does not belong to the genus *Ægeria.*

4. *Æ. Syringæ.* H.

Brown; fore-wings with a transparent line at base; hind-wings transparent, with a brown border, fringe, and subcostal spot; antennæ, palpi, collar, first and second pairs of tarsi, and middle of the intermediate tibiæ rust-red; middle of the tibiæ and the tarsi of the hind-legs yellow. Expands one inch and two lines. *Larva* lives in the trunks of *Syringa vulgaris*, the common lilac.

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* Credited to Mr. Say, in the Catalogue of the Insects of Massachusetts, by mistake.

5. *Æ. exitiosa.* Say.

Steel-blue; *male* with the wings transparent, the margins and fringes, and a band beyond the middle of the first pair steel-blue; palpi, collar, edges of the shoulder-covers and of the abdominal segments, two bands on the tibiæ including the spurs, anterior tarsi, and lateral edges of the wedge-shaped tail pale yellow; *female* with the fore-wings opaque; the hind-wings transparent, with a broad opaque front-margin and the fringe purple-black; antennæ, palpi, legs, and abdomen steel-blue, the latter encircled in the middle by a broad saffron-colored band. Male expands from nine to thirteen lines; female from fifteen to seventeen lines. *Larva* inhabits the trunks and roots of the peach and cherry trees, beneath the bark.

The larva is the well-known peach-tree borer, which annually injures to a great extent or destroys numbers of these trees. For the means of preventing its ravages, see Say's Entomology, Vol. II, and my communication in the New England Farmer, Vol. V, p. 33. The insects above described, though very dissimilar, are really the sexes of one species. I have raised many of them from the larvæ, and have also repeatedly captured them, in connection, on the trunks of peach and cherry trees.

6. *Æ. fulvipes.* H. (Catalogue.)

Blue-black; wings transparent, margin and fringes, and a transverse band beyond the middle of the first pair blue-black; antennæ black, yellowish at the end; palpi beneath, a spot on the thorax under the origin of the wings, intermediate and hindmost tibiæ, all the tarsi, and the basal half of the underside of the abdomen orange-colored; hindmost tibiæ somewhat thickened by a covering of tawny hairs. Expands thirteen lines.

7. *Æ. Tipuliformis.* L.

Blue-black; wings transparent, with the margin and fringes blackish; the first pair with a transverse blue-black band beyond the middle, and a broad one at tip streaked with copper-color; antennæ black; palpi beneath, collar, upper edges of the shoulder-covers, a spot on each side of the breast, three narrow rings on the abdomen, ends of the tibiæ and the spurs pale golden yellow; tail fan-shaped, blue-black. The male has an additional transverse yellow line between the second and third abdominal bands. Expands from seven and a half to nine inches. *Larva* lives in the pith of the currant-bush.

This destructive insect is not a native, but has been introduced from Europe with the cultivated currant-bush.

8. *Æ. scitula.* H.

Purple-black; wings transparent, with the margins golden yellow; the first pair with a narrow purple-brown band beyond the middle and a broad one at the tip ornamented with golden yellow lines; fringes blackish; front and orbits covered with silvery white hairs; antennæ black; palpi, collar, upper edges of the shoulder-covers, a narrow band at the base of the abdomen, a dorsal spot behind it, a broad band around the middle, the lateral edges of the fan-shaped tail, anterior coxæ, sides of the breast, tibiæ and tarsi except at the joints, with the spurs golden yellow. Expands about eight lines.

This beautiful little species is easily distinguished by the prevalence of yellow on the under-side of the body and legs.

9. *Æ. Pyri.* H. (New-England Farmer.)

Purple-black; wings transparent, with the margins, a narrow band beyond the middle of the first pair, and a broad one at tip purple-black, the latter streaked with brassy yellow; antennæ blackish; palpi beneath, collar, edges of the shoulder-covers, a broad band across the middle of the abdomen, a narrow one before it, an indistinct transverse line at base, the posterior half of the abdomen beneath, the sides of the breast, anterior coxæ, legs except the joints of the tibiæ, and the lateral edges of the wedge-shaped tail golden yellow. Expands six lines and a half. *Larva* lives under the bark of the pear-tree.

For some further particulars respecting this species, see my communication in the New-England Farmer, Vol. IX. p. 2, 1830.

Mr. Edward Doubleday presented me with a new species of *Ægeria* which he captured in Florida, and Dr. J. W. Randall has still another which was taken in Massachusetts. To these gentlemen belongs the right of first naming and describing these species which they have discovered, and I do not feel myself authorized to anticipate them.

## Genus XII. Thyris. Illiger.

*T. maculata.* H. (Catalogue.)

Brownish black, sprinkled with rust-yellow dots; hind-margins of the wings deeply scalloped, with the edges of the indentations white; each of the wings with a transparent white spot,

which in the fore-wings is nearly oval and slightly narrowed in the middle, in the hind-wings larger, kidney-shaped and almost divided in two; palpi beneath, a spot before the anterior coxæ, the tips of the tarsal joints above, and the hind-edges of the last three or four abdominal segments white. Expands from six to eight lines.

This species comes very near to the *fenestrata* of Europe, but is sufficiently distinct from it.

Mr. Doubleday has presented to me a much larger species of *Thyris*, which was captured by him in Florida, and was new to my collection. There is a figure of it in M. Boisduval's Hist. Nat. Ins. Lépidopt. Vol. I, pl. 14, where it is named *T. lugubris*. This name has not yet received the proper sanction of a description; but, taking into consideration the circumstances under which this nondescript came into my possession, I do not think proper to describe it myself at this time.

## Tribe II. SPHINGES ADSCITÆ. L.

### Family IV. AGARISTIADÆ. H. *The Agaristians.*

*Hesperi-Sphinges.* Latr. *Agaristides.* Boisd. *Zygænidæ.* Kirby.

#### Genus XIII. ALYPIA. (Hübner.) Kirby.

*Zygæna* and *Sesia.* F. *Agarista.* Latr.

*A. octomaculata.* F.

Black; with two sulphur-yellow spots on the fore-wings, and two white ones on the hind-wings; shoulder-covers and front sulphur-yellow; first and second pairs of tibiæ thickly covered with orange-colored hairs. Expands from eleven to fifteen lines. *Larva*, as represented by Abbot, (Ins. Georg. p. 8, pl. 44,) cylindrical, elongated; yellow, with transverse rows of black points, slightly hairy, and without a caudal horn. It lives on the grape-vine, and encloses itself in a cocoon in the earth.

In some individuals there is a white spot near the end of the abdomen, and the inner white spots of the hind-wings are enlarged and cover the whole base of the wings. Mr. Kirby (Fauna Bor. Amer. IV, p. 301, pl. 4, fig. 5,) has described another species of Alypia, a native of Nova Scotia and Canada, and names it A. MacCullochii.

## Family V. ZYGÆNIADÆ. H. *The Zygænians.*

*Zygænidæ.* Stephens. *Zygénides.* Boisd.

Hitherto I have not met with any insects in the United States belonging to this family; but Dr. Hornbeck has sent to me, from St. Thomas, a species which not only seems to be undescribed, but must constitute a new genus, the characters of which are given in the Synopsis, and those of the species in the note below.*

## Family VI. GLAUCOPIDIDÆ. H. *The Glaucopidians.*

*Procrides* and *Zygénides.* Boisd. *Zygæniadæ.* H. Cat. *Ctenuchidæ.* Kirby. *Callimorphæ.* Westwood.

### Genus XV. Procris. F.

*Ino.* Leach.

*P. Americana.* = *Aglaope Americana?* Boisd. = *dispar.* H. (Cat.)

Blue-black; with a saffron-colored collar, and a fan-shaped, somewhat bilobed, black caudal tuft. Expands from ten lines to one inch. *Larva*, according to Prof. Hentz, hairy, green, with black bands. It is gregarious, and devours the leaves of the grape-vine, and undergoes its transformations in an oblong-oval, tough, whitish cocoon, which is fastened to a leaf.

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* Genus XIV. Mastigocera. H.

From μάστιξ, *a whip or thong*, and κέρα, *horns;* the antennæ being thickened in the middle and tapering at each end like a whip lash. In the West Indian insect to which I have applied this name, the antennæ agree, in the main, with those of *Ægocera*, as described by Latreille and other authors; but most of its other characters disagree, and it has an entirely different form from that of the type of the genus. These characters are so very striking, that I have ventured to propose this new genus, although the transformations of the species are unknown to me.

*M. vespina.* H.

Light rust-brown; wings immaculate; collar, first abdominal segments above, third below, and a triangular spot on each side, white; head, thickened part of the antennæ, edge of the thorax behind the collar, and a large triangular spot on each side of the second abdominal segment, black; breast black, spotted with white; first and second pairs of thighs, except at base, middle of the hind-pair, and extremity of the tibiæ, black. Expands from one and a half to one inch and three quarters. Inhabits the island of St. Thomas, W. I.

The *Zygæna Eunolphus* of Fabricius, and the *Pretus* of Cramer are probably congenerical and closely allied to this species.

This insect appears to be the same as the one figured in Guérin's Iconographie and in Griffith's Cuvier, under the name of *Aglaope Americana*, Boisduval; but it is not an *Aglaope*, for it has a distinct, spirally-rolled tongue.

## Genus XVI. Glaucopis. F.

The insects which, at present, I refer to this genus, belong to *Zygæna* of the *Entomologia Systematica* of Fabricius; whose *Z. Glaucopis*, if it was not actually the type, furnished the generical name which this author gave, in his last work, the *Systema Glossatorum*, to this group of his former *Zygænæ*. Several of the insects, which Mr. Westwood, in his edition of Drury's Illustrations, refers to the genus *Callimorpha*, without doubt belong to the family *Glaucopididæ*. Mr. Kirby has placed one species, after *Lithosia*, in a family which he names *Ctenuchidæ*. These insects seem to me much more nearly allied to the *Sphinges adscitæ* than to the *Phalænæ* of Linnæus, with which also they agree in their diurnal flight, and in their transformations, so far as the latter are known. Although they do not appear to be strictly congenerical, I prefer to arrange them, for the present, under the genus *Glaucopis*, in groups or subgenera, which, when the larvæ and their transformations are better known, it may be proper to raise to the rank of independent genera.

### Subgenus *Syntomeida*. H.

**Antennæ bipectinated, tapering at each end. Tongue moderate, spirally rolled. Palpi short, not extending beyond the clypeus, slightly curved and hairy at base, covered with short close scales; terminal joint somewhat acuminated. Wings elongated, hind-pair small, with the discoidal cell closed behind by an acute-angled nervure, the anterior branch of which crosses the subcostal nervure and ends near the tip of the wing. Body cylindrical, rounded and not tufted behind, and with a rounded tubercle on each side of the first abdominal segment. Spurs of the posterior tibiæ four, small, and approximated.**

1. *G.* (*S.*) *Ipomœæ.* = *Sesia Ipomœæ.* Œmler, in letters.

Fore-wings greenish black, with three yellowish white dots near the front margin and two others close together beyond the middle; hind-wings violet-black, with a transparent colorless spot at base; body tawny orange; antennæ and head black, the latter spotted with orange; a broad stripe on the shoulder-covers, a transverse spot on the thorax behind, and the incisures of the abdomen, black; legs violet-black; coxæ beneath, and a spot on the thighs, orange-colored. Expands one inch and three quarters.

I received this species from Dr. A. G. Œmler, of Savannah, Georgia, and have adopted the specific name that he gave to it, and from which it is to be presumed that the larva lives upon the *Ipomœa*. The *Melanthus* and *Nycteus* of Cramer resemble it somewhat, and are probably congenerical with it.

Subgenus *Cosmosoma*. Hübner.

Antennæ long, very much attenuated at the end, and with a double row of very short pectinations beneath. Tongue moderate, spirally rolled. Palpi long, curved upwards, and extending beyond the clypeus; the joints cylindrical, covered with small scales, a little hairy at base, and obtuse at tip. Wings elongated, hind pair rather small, and with the discoidal cell and nervures as in *Syntomeida*. Body cylindrical, rounded and not tufted behind, and with a small tubercle on each side of the first abdominal segment. Spurs of the hindmost tibiæ four and of moderate size.

2. *G.* (*C.*) *Omphale.* Hübner (according to Say). = *Ægeria Omphale.* Say.

Scarlet; wings transparent, veined and bordered with black, the first pair with a small black subcostal spot, and the black border very much widened at tip; head azure-blue; antennæ black, with the tips white; two terminal joints of the palpi, and a line on each shoulder-cover black; four azure-blue dots in a transverse row on the fore-part of the thorax; last four segments of the abdomen black, with four azure-blue spots on each side, and a dorsal black line extending from the middle of the second segment including in it seven azure-blue spots; belly and outside of the second pair of tibiæ black. Expands one inch and a half or more. Inhabits Florida.

For a specimen of this beautiful insect I am indebted to Mr. Doubleday. It cannot belong to the genus *Ægeria*, to which it was referred by Mr. Say, in his American Entomology, where it is figured. As Hübner's works are not accessible to me, I have drawn up the characters of the subgenus *Cosmosoma* from the specimen of the *Omphale* in my possession. *Zygæna Andromacha* of Fabricius and the *Caunus* of Cramer probably belong to the same subgenus.

Subgenus *Lycomorpha*. H.

Antennæ rather short, curved, toothed or with very short pectinations on each side, which give to the joints, when seen from beneath, a cordate or bilobed appearance. Tongue about half as long as the body, spirally rolled. Palpi short, hardly extending beyond the clypeus, nearly horizontal and but slightly curved at base, and covered with large and rather loose scales. Wings not elongated, rounded at tip; discoidal cell of the hind pair long, extending nearly to the hind-margin, and

closed by an oblique nervure. Body rather short, nearly cylindrical, not tufted behind. Spurs of the hind-legs three, two at the end and one beyond the middle of the tibiæ.

3. *G.* (*L.*) *Pholus.* Drury.

Blue-black, or deep indigo-blue, wings at base and shoulder-covers orange-colored. Expands fourteen or fifteen lines. *Larva*, according to Mr. Leonard, pale green, with yellowish spots running into the green (in a specimen preserved in spirit, pale green mottled with red;) head black, covered with a few short whitish hairs; body sparingly clothed with rather long hairs, which are white at the sides and black on the back, the hairs arising singly from minute tubercles, those on the third segment the longest and with the others before them directed forwards. It eats the lichens on stone heaps and walls in shady places, and undergoes its transformations in a thin silky cocoon.

This pretty species is often seen flying in considerable numbers in the fields, throughout the day, and at first sight would be mistaken for a species of *Lycus*.

Subgenus. *Ctenucha.* Kirby.

Antennæ pectinated on both sides in the males, thickened in the middle with extremely short pectinations in the females. Tongue moderate, spirally rolled. Palpi slender, rising beyond the clypeus, nearly cylindrical and obtuse, covered with small close scales, and somewhat hairy at base. Wings in some rather narrow, in others widened and rounded at the tip; discoidal cell of the hind pair closed by an angulated nervure. Body nearly cylindrical, enlarged a little behind in the females, with a few minute tufts at the sides of the segments, obtuse and slightly tufted at tip; first abdominal segment with a conspicuous tubercle on each side. Spurs of the hind-legs small, four in number, two terminal, and two beyond the middle of the tibiæ.

4. *G.* (*C.*) *semidiaphana.* H.

Slate-colored; wings rather narrow and subacute; first pair brownish slate, with the anterior edge clay-colored; hind-wings semitransparent in the middle; head and antennæ black; collar, front edge of the breast, and base of the palpi, orange-colored. Expands fifteen to sixteen lines. Inhabits the Middle and Southern States.

Dr. Charles Pickering, several years ago, gave me specimens of this insect, which he captured near Philadelphia; there are also specimens of it, in the cabinet of the Boston Society of Natural History, taken in North Carolina by Prof. Hentz; and I have recently received several individuals, in fine preservation, which were found by Mr. Doubleday in Florida. This species some-

what resembles, in form and color, the *Thetis* of Linnæus and Drury.

5. *G.* (*C.*) *Latreillana.* = *Ctenucha Latreillana.* Kirby.

Fore-wings dusky drab, with a silky lustre, and the anterior edge clay-colored; hind-wings rusty black; fringes of all the wings white, interrupted with black in the middle; top of the head, orbits behind, base of the palpi, front of the breast, and a spot on the fore-part of each shoulder-cover orange-colored; thorax, abdomen, and coxæ, glaucous or greenish blue with a silky lustre; belly and legs light brown. Expands almost two inches. Inhabits New-Hampshire and Maine, and, according to Mr. Kirby, Canada and Nova-Scotia.

I am indebted to the Rev. L. W. Leonard for one specimen, taken by him in New-Hampshire, and to Dr. J. W. Randall for another from Maine. Although they are rather smaller than Mr. Kirby's *Latreillana*, and do not exactly agree with the description in the Fauna Bor. Amer. Vol. IV, p. 305, I think that they must be referred to his species. This insect has precisely the same antennæ and nearly the same form as the *Glaucopis* of Drury and Fabricius, stated by the latter author to be a native of Carolina, and is, without doubt, generically allied to it, and probably also to several other American species, such as the *Pylotis* and *collaris* of Drury. The following species, from the figures given of them, seem also to belong to the same generical group; viz. *Glauca*, *Celadon*, *Circe*, *Cœlestina*, *Asterea*, *Cephise*, *Alecton*, *Cassandra*, and *Porphyria* of Cramer.

Subgenus *Psychomorpha.* H. (Catalogue) = *Callimorpha.* Westwood.

Antennæ in the males pectinated on both sides, the pectinations rather short, setaceous in the female, according to Drury. Tongue moderate, spirally rolled. Palpi slender, nearly horizontal, extending a little beyond the clypeus, covered with loose hairs so as to conceal the joints. Wings short, somewhat triangular, with the outer margins rounded; discoidal cell of the hind pair short, closed by a sinuous nervure. Body slender, hairy at tip. Legs short, hairy; spurs of the hind tibiæ three, slender, nearly concealed by the hairs.

6. *G.* (*P.*) *Epimenis.* Drury. = *Psychomorpha maculata.* H. (Catalogue.)

Brownish black; fore-wings sprinkled in spots with light blue scales, which form a narrow band near the hinder margin, and marked with a large yellowish white patch beyond the middle; hind-wings with a broad dark orange-red band behind the middle. The white spot of the fore-wings is indented towards the

middle of the wing, and on the under side there is a small triangular spot near the base of the wing, and a short transverse one beyond it which unites behind with the angular projection of the large white patch. Expands rather more than one inch.

I captured this beautiful insect on the wing at midday, in Milton, Mass., and have since seen it flying among the shrubbery at Mount Auburn, Cambridge. There is also a broken specimen, among Mr. Say's insects, which was taken in Indiana. My specimen is a male, as is also the one in Mr. Say's cabinet, and they have the anal organs very large and hairy. Drury's specimen seems to have been a female, for he says the antennæ are setaceous. It is possible that this insect is not one of the *Sphinges adscitæ;* but I place it here on account of its diurnal habits, and a certain resemblance, more easily seen than described, which it bears to some of the *Glaucopididæ.* It does not agree generically with the types of Latreille's genus *Callimorpha.* When my Catalogue of the Insects of Massachusetts was published, I had not seen a colored copy of Drury's Illustrations, and failed to recognize this insect in the uncolored one which I used.

Cambridge, Mass., Feb. 1, 1839.

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## Art. IV.—*On American Amphibia;* by Abm. Sager, M. D.

Detroit, (Mich.) March 5, 1839.

TO PROF. SILLIMAN.

*Sir*—If the following observations upon some of the American Amphibia, and description of some new ones, appear worthy of publication, you will confer a favor by inserting them in your valuable journal.

The structure and arrangement of the teeth, are of acknowledged classific importance in distributing animals in a natural series, and like most other characters are of variable importance in different classes, depending upon the constancy and generality of their existence, structure and arrangement. In the Class Amphibia, Lat., Order Batrachia, Brongn., they are generally regarded as of generic value, (and here let me say that I have frequently verified the truth of the observations of Drs. Davy, Weber and others with regard to the biauriculate structure of the heart in this

class, by which the ordinal character of M. Brongn. is invalidated,) thus Rana and Hyla are distinguished from Bufo, by the presence of teeth in the upper jaw, and in two transverse processes of the palate, generally anterior to the internal nares, sometimes between, but never behind them, the toads being quite destitute of both. The Salamandrae possess not only teeth in both jaws, but also palatines, which according to most authors, are arranged in two longitudinal rows. This character does not agree with my observations upon our Salamandrae. Indeed so varied is the arrangement of the palatine teeth in those American Salamanders which have fallen under my observation, that if much importance be attached to this character, they might be divided into several sub-genera. My observations have not been sufficiently extensive, to enable me to determine whether a classification founded upon agreement in the general dental arrangement of the palatines in this class, would be natural or coincident with one based upon a general correspondence in all the generic characters. Future investigation may settle that point. At all events it is believed that the modifications in the arrangement of the palatine teeth from their constancy will be found to be of essential importance in determining species, the more so from the admitted fact that the color of these animals (a character much employed for this purpose) is extremely variable. I shall content myself by submitting the result of my investigations. The palatine teeth of the Salamandra erythronota, Raf., are arranged in two longitudinal palatine rows, slightly diverging as they proceed backward. This is the only species that agrees generically with the description. The Sal. interrupta, Gr., has two longitudinal patches of palatine teeth, each composed of several rows, nearly in juxta-position centrally. In the Sal. *agilis*, there is but a single longitudinal patch of palatines composed of several rows so arranged as to form very acute angles pointing forwards. The Sal. variolata, Gill., has beside an armation of the longitudinal palatine ridge similar to the last, two partial rows on the transverse palatine ridge, interrupted in the middle, curved backward and joined to the longitudinal patch. Those of the Sal. maculata, Gr., are similar to the last, but the longitudinal patch has fewer rows. The palatines of the Sal. rubriventris, Gr., differ only from the Sal. variolata in having the transverse and longitudinal rows separate. The Sal. bilineata, has no longitudinal rows, and the straight transverse row has a

wide central interruption. The Sal. *lurida*, has an uninterrupted transverse palatine row forming an obtuse angle directed forward. The Sal. subviolacea, Bart., corresponds with the last in having but a transverse row, but may easily be distinguished by this row being undulating with a slight central angle. The palatine teeth in all are curved backward and very acute. It will be perceived that these nine species may be divided somewhat into three groups, founded upon the possession of longitudinal or transverse teeth only, or both combined. In nearly all, the general structure of the tongue is similar to that of the Ranae, but is more closely bound down; the sides and the posterior extremity which is quite short and rounded, are free but not capable of being projected from the mouth as in the Ranae.

In the Sal. lurida and subviolacea, it is almost perfectly bound down all its length. I would here remark that the expression, "tongue not attached at the bottom of the gullet but to the edges of the jaw," found in the works of the most eminent authors, when applied to the Ranae, conveys an erroneous idea. I believe in all the species of the restricted genus Rana, the tongue is composed of two muscles a hyo-glossus and genio-glossus, the former attached to the horns of the hyoid cartilage, the other to the angle of the lower jaw. Such is the structure in all the species of Rana, Bufo and Salamandra I have examined. In the male Bufo Americanus, Le Conte, as well as in the Hylae, there is a sac beneath the tongue opening by an orifice on each side of it; a fact not mentioned in any of the books to which I have had access. In the works of some of our American Herpetologists, the fact of the existence of the external branchiae in the early period of the development of the young tadpole, appears to be doubted. I possess many specimens illustrative of this fact, as well as the development of the anterior extremities of the tadpole of the Ranae, previous to their protrusion.

The following appear to be nondescript species:

Sal. *agilis*, Nob. Palatine teeth an oblong patch, composed of several rows so arranged as to form very acute angles pointing forward; curved backward; length $2\frac{3}{4}$ in.; head $\frac{1}{3}$ in.; tail $1\frac{1}{4}$ in.; fore legs $\frac{1}{4}$ in.; hind legs $\frac{1}{3}$ in.; head oval, flattish; snout obtuse; nostrils lateral, small, round; eyes prominent; body and tail round, the last terete, pointed; toes minute, four anterior, five posterior. Color of the head, back and tail above testaceous or lateritious,

dotted with livid; the head so thickly dotted as to obscure the ground color; sides deep livid, spotted with straw color; beneath straw colored, spotted with livid—sometimes the back as well as sides, uniformly deep livid with minute pale yellow dots; (a difference not depending upon age, sex or season.) Skin smooth.

Sal. *lurida*, Nob. Palatine teeth a single transverse row, forming a very obtuse angle, pointing forward; body somewhat granulated, sub-quadrangular; tail compressed, three fourths the length of the body lanceolate, sub-acute; skin beneath the throat folded; color above dark olive brown; beneath sub-fuscus; sides, tail and beneath spotted with pale yellow.

*Dimensions.*—Total length $4\frac{1}{8}$ in.; head and neck $\frac{5}{8}$ in.; head $\frac{5}{8}$ in. wide; body $1\frac{3}{4}$ in.; tail $1\frac{3}{4}$ in.; fore legs $\frac{3}{4}$ in.; hind legs $\frac{7}{8}$ in.

*Description.*—Head rather large, gibbous, short, oval; snout quite round before; commissure of the jaws extends to the centre of the eyes; eyes large, prominent; nostrils minute, subovate; neck thicker than the body; skin beneath plaited; body thick; the spine forms a prominent ridge; tail compressed, linear lanceolate, somewhat obtuse at tip, the edges obtuse; legs short, but broad; toes much depressed; head above smooth, shining with minute pores; body and tail somewhat granulated; color above very dark brown, tinged faintly with olive; beneath yellowish brown; an irregular row of yellow spots along the sides and inferior part of the tail; beneath irregularly spotted with the same. The whole abdomen and inferior part of the sides appear to have a pure pale yellow ground. When viewed with a glass, numerous minute depressions are visible which except in a few spots are bounded with dark brown; Iris dusky golden. Perhaps a variety of Salspicta, Harl.

Scincus *lateralis*, Say. var? Perhaps a distinct species.

*Description.*—Total length $6\frac{1}{4}$ in.; length of head $1\frac{1}{4}$ in.; width $\frac{3}{8}$ in.; head and trunk $2\frac{5}{8}$ in.; tail $3\frac{1}{8}$ in.; form of head ophioid; trunk sub-quadrangular; tail round, terete; a single row of obtuse teeth in each jaw; no palatine teeth; tongue non-extensile, emarginate at tip, soft, free; nostrils near the tip of the snout, lateral, oval, bordered by a membrane; eyes dark, a rudimentary third eye-lid; the true lid covered with tetragonal scales; tympanum a little below the surface, meatus auditorius externus $\frac{1}{12}$ in. long, oblong oval, transverse, its outer margin serrated an-

teriorly; the anterior legs including the toes $\frac{3}{4}$ in.; toes 5, free; order of length 3 and 4 equal, 2–5–1; 1st, about half the length of 2d, which is one third shorter than 3d and 4th; nails all much compressed, deep, much curved at point and very acute; posterior extremities $1\frac{1}{16}$ in.; toes five, much longer than the anterior ones; order of length 4–3–5–2–1 a regular gradation from $\frac{1}{8}$ to $\frac{7}{16}$ of an inch, the fifth opposable to the others; nails as on the anteriors. Head covered with plates; scales all round, imbricate and wider than long; two rows of larger ones sub-quadrangular on the sides of the lower jaw and beneath it, a large triangular one beneath its extremity; scales of the tail larger and wider in proportion to their length than those of the body; the central inferior row much larger than the others; toward the end of the tail the scales become sub-verticillate, the tip sub-acute; 28 rows of scales surround the trunk; the scales beneath the toes sub-serrate, beneath the feet tuberculate; anus a transverse slit; color above olive brown; head immaculate; a narrow line of dark brown through the first lateral row of scales; another through the third, extending from the head to the tail, then approximating and passing on the first and second rows, one third the length of the tail; on the neck an oblique line, between them; a broader stripe of the same color separates the back and sides, includes a row, and half the two adjoining rows of scales, and extends from the eye to the middle of the tail becoming narrower on the tail; another somewhat obscure line of the same color, extends from the lower angle of the tympanum to the tail where it is lost; legs above of the color of the back with three irregular dark longitudinal stripes, the central one wider; sides and trunk beneath with a tinge of yellow on the latter; tail and legs beneath pale lead color.

The species sometimes attains a size from $\frac{1}{2}$ to $\frac{2}{3}$ larger than the specimen from which this description was drawn. It probably belongs to the genus Siliqua of Gray. Frequents houses. Found, though rarely, in Detroit.

This drawing represents the upper surface of the head.

ART. V.—*Translations relative to Bowlders and Cobalt Ores, from the Néues Jahrbuch für Mineralogie, Geognosie, Geologie und Petrefaktenkunde, herausgegeben von Dr.* LEONHARD *und Dr.* BROWN. *Jahrgang*, 1838. *Rev.* W. A. LARNED.

## I. *On the Recent Explanations of the Phenomenon of Erratic Blocks;* by Hr. Prof. B. STRUDER.

THE wish expressed in your last letter of publishing in the Jahrbuch, my geological remarks upon the recent explanation of the phenomenon of erratic blocks, is the occasion of the following communication.

After all the endeavors, observations, and speculations of the last ten years, we see the phenomenon of erratic blocks still veiled in a mist, which hinders us from taking a full and exact view of them, and which has not as yet permitted a general elucidation. Hence we are disposed to view every new theory with favor, and we overlook at first its difficult points, though they may be not a few, because of the satisfactory explanation of others, on which we have hitherto labored in vain.

The floating or forcing of bowlders by powerful currents of water, still appears to me, to afford the explanation, which best agrees with the facts, although at the same time I confess that I am not prepared with an entirely satisfactory answer to several admitted and recent objections. In order to hold up the blocks while floating from the Alps to the Jura, we suppose instead of streams of pure water, streams of mud and detritus, without being able fully to show what became of this smaller rubbish. In order to carry them over the deep Swiss lakes or the Baltic Sea, we assume a kind of lateral impulse, while we make the avulsion of the blocks cotemporaneous with the rise of the mountain and the sinking of the sea: but, it is clear from examinations in Switzerland, that the spread of the blocks must have been later than the formation of the present molasse-vallies,* which however we deduce from the last heaving process of the Alpine range; that, moreover, in the later epoch of the molasse formation, the sea in

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* Molasse is a term, descriptive of a soft green sandstone, occurring throughout the lower country of Switzerland.—*Lyell, Principles of Geology, Vol.* 4, p. 75.—TR.

the interior of Switzerland, had only a very small depth and alternated with dry land such as we now regard as low land, (tief land); and, finally, that the elevation of the Alpine chain could scarcely have been an instantaneous thrusting up of the whole mountain mass, in which the sea might have been slung on high with it, but a very complicated process continued through a long space of time.* The great depth of the Swiss lakes has ever been the principal objection with the opponents of that explanation, and the ease with which the new ice and glacier theory sets aside this difficulty, accounts of itself for the interest with which it has been received. The difficulty lies not, as I think, in carrying the detritous streams and blocks over the lakes. The water-course could do no more than force a part of the water of the lake, and, considering the small difference of specific gravity, the height and rapidity of the streams, hardly a very important part, out of its basin and mingle with it; had the stream at once poured itself out entirely over the whole lake, in that case the back portion of the detritus would flow on over it, as we see the upper water in our lake move over the deep, still water. The separation of the solid materials from the detritous water might to be sure raise the bottom of the lake, yet not more than we see the bottom of the molasse-vallies now elevated in many places by diluvial ruins, that is, at the highest one hundred feet. Nor is it difficult of solution why the basins of the lakes have not been entirely filled up by the later transportation of smaller blocks such as have occurred in part within the historical period; for, originally these blocks were not, as is generally supposed, so naked and free, as we now see them, but covered with thick coatings of rubbish. This appears very clearly, among other examples, in the immediate neighborhood of Berne. A row of low hills stretches in an arch convex to the west across the Aar-valley close to the west end of our city, which has used its contiguous eminences for breast-works. In the late demolition of the fortifications, these eminences which were universally supposed to be works of art thrown up on the common level of the ground, were penetrated to their center and it was found that they consisted for the most part of enormous heaps of Alpine

* The imbedding among the diluvial ruins of the blocks at Strâtligen and Utznach, of unchanged pines and firs, plants and insects of the present time in brown coal, appears to place the spread of this detritus at a very recent epoch.

blocks, whose interstices were entirely filled up with smaller gravel and sand, which also occurred independently, in great masses, as well over as underneath and along side the accumulation of blocks. This chain of hills is manifestly the last remains of a much more general overspreading of detritus, which has been torn to pieces and carried away by later water-courses. A glazier-mound (Gletscher-Gandecke) it is not, as I at first supposed, on becoming acquainted with the new veins, and Hr. v. Charpentier himself is the person who corrected my mistake; as just at the time of our visit to the diggings, clear traces were brought to light of orderly arrangement and a quiet subsidence from water. In the mean while, the difficulty, in which the masses of smaller rubbish place us, will be no reason in geology, which has grown hardened against difficulties of this kind, for rejecting the whole theory of diluvial currents, in favor of which there are so many other facts. Indeed we have only to suppose the original lakes to have been some hundred feet larger in extent than at present, and then we have surrounding our lakes considerable plains and broad valley flats, which the eye at once perceives arose from the emptying of earlier, much more extended lake basins, and which have in fact received very large quantities of that rubbish.

The ingenious theory Hr. Venetz has constructed, on the phenomenon of bowlders, and which Hr. v. Charpentier has been able with so much acuteness to bring into consistency with the more recent geological views, builds for the blocks a bridge of ice over the Swiss lowland and the abysses of her lakes and has them sledded down by the advancing glacier, in rows (tragen in Guferlinien) to its outermost limit, where they heap up in ice-piles or glacier-walls. The glaciers, hitherto blocked up on the back central chain, broke out from all the slope vallies upon lower Switzerland, for the most part overspread it, and then mounted to a considerable height up the Jura. The rubbing of the ice occasioned the jags and erosions often visible to a great height on the rocky walls of our slope vallies and which have hitherto been regarded as evidence of the ancient water-courses. And in order to support the assumption of so great a cooling of the climate, a general elevation and distension of the whole Alpine region and its contiguous parts is presumed to such a height as to sink the mean annual temperature of the lowland down to

that of Chamouni. This theory rests principally, if not exclusively, on observations made in the vallies of Valais, Savoy, and Vaud. The appearances in the Aar-valley are less favorable to it. We see around Berne not only the declivities on both sides of the valley but the valley-bottom itself covered with blocks, and these are not in any respect, as we have just seen, accordant with glacier ramparts. Moreover, on the plateau of Langenberg and Belpberg, elevated nigh a thousand feet above Berne, bowlder almost strings itself to bowlder; the whole surface of these hills, which lie in the midst of the Aar-valley, is thickly strewn with blocks, and although here and there we may suppose ourselves to have observed a linear accumulation like the Swedish osar,* yet is the direction of these ramparts usually parallel with the direction of the valley; they appear to be the remnants of an earlier detrital coating mostly carried away by later streams, and not moraines.† Moreover, in the upper Aar-valley, in the region of Meiringen, exist facts, which if not in direct opposition, are yet not in the desired coincidence with the glacier theory. There, too, we see no old moraine. The blocks occur at very different heights; they have been transported high over the Brunig, indeed more than two thousand feet high over the Aar-valley; we find them in multitudes at the Scheideck-pass and at Zaun perhaps a thousand feet above the valley-bottom; then again at Rüti above Meiringen, which may be situated some hundred feet lower than Zaun; finally, almost in the valley-bottom itself, by Willigen, and on the Kirchet, and lower in the valley by Brienzwiler, Brienz, Oberried, &c. But the glacier theory seems to me to be pressed with the most weighty objections on the side of physics. Supposing the present quantity of snow on the surface of Switzerland to have remained unchanged, while the requisite refrigeration is derived from an alteration of the earth's axis or any other source, still the question at once arises whether in fact all the vallies would fill with ice and then this flow together towards Switzerland in one enormous, almost horizontal glacier? Leaving too unsettled, the mode in which the as yet enigmatical movement of the glaciers is effected, granting the hitherto gene-

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* Oasar, elongated hills. Phillips, Geol. p. 208. In Swedish *as* is a chain of hills, and *asar* is the plural form and is more properly written *osar*.—Tr.

† Moraine, the rubbish brought down by glaciers and left after the ice has melted.—Tr.

rally received explanation of Saussure and Escher, that it is by the pressure of snow on the heights falling down, to be untenable, still we are justified in asking for analogies, in the countries where the state of things, which they assume, actually exists. If it requires a fall of temperature of only 6° at the highest in order to secure the forming of glaciers at the foot of the higher snow mountain ranges, why do so many Alpine valleys, whose annual temperature falls below the requisite degree remain destitute of them? Why is not the Altai entirely encircled with ice, where the temperature of the surrounding lowland scarcely rises above 1°? Why hear we not of such colossal glaciers and immense plains in Scandinavia and Greenland covered several thousand feet entirely with ice? Why are not Chamouni, Latschthal, Bagne, &c., filled with glaciers? Manifestly the origination of glaciers is not dependant solely on the relations of temperature; there appears also to be required in order to its being filled with glaciers, a depth and breadth of the valley fixed in relation to the height of the adjacent snow mountain range, which ought not to be passed over. This simple remark must at once have forced itself upon geologists, so well acquainted with the Alps as those who have attempted to establish the new theory; and, apparently in order to meet this objection, Hr. v. Charpentier thought it necessary to make the lowering of the mean temperature cotemporaneous with a considerable elevation of the mountain range, in which however, it has not become clear to me, how it is consistent that the land should be powerfully swollen by internal heat, and at the same time while this higher heat is streaming out, cover itself with ice? Granting, meanwhile, the possibility of such a state of things, inasmuch as no rise of annual temperature is reported of Scandinavia at the present time in the process of elevation, we are obliged again to inquire, here too, after analogies, and the Himalaya at once offers itself to us as a mountain range, which might well be likened to elevated Alps. This lies, to be sure, 15° farther south than the Alps, but its summits considerably *exceed* the height, (about 20,000 feet,) which H. v. C. requires for the loftiest Alpine top in the diluvial era, and in still stronger contrast does the elevation of its valley-bottoms and plateaux surpass that (5 or 6000 feet) to which the valley-bottom of Switzerland ought according to the theory to have been raised at that time. The state of things of the one moun-

tain will allow of being transferred, with sufficient accuracy for our object, to the other, if we deduct about 3500 feet from the Himalaya heights in comparison with the Alps—which is about the difference of the snow limits on the south slope of both ranges. And what state of things do we find in the Indian Alps? "It is remarkable," says RITTER, "that there never has been any report of a single glacier formation throughout Himalaya. The sublime phenomenon of glaciers, which appear to have attained their most perfect development in the European Alp-formation, according to any observations hitherto made, never occurs in the Himalayan Alp-region." Thus, at first sight we are cut off from any comparison here and instead of immeasurable fields of ice, many thousand feet thick, which we expected to see, we only meet with snow on the peaks and caps in no greater, rather in smaller quantities than on the Alps at their present heights. But a closer view, points out another result, which may be pronounced almost decisive of our question. With the elevation of the ground, all the isothermal lines mount up rapidly in height. On the south slope of the Himalaya, we meet with the extreme limit of cultivation at 9400 feet; in the deep indented vallies of the interior, it mounts up to 10,700 feet; on the plateau land, to 12,800 feet; and on the interior table land of Thibet, which can be best compared with the upraised lowland of the molasse region, the same appears at 14,000 feet, whence it goes no higher. This elevation would correspond to perhaps 10,000 feet, in our latitude, or to the heights of Diableret and Fitlis. Hence, a rise of ground, even twice as great as that required by H. v. C., never appears to produce the formation of such extraordinary glaciers as must be assumed in order for the glacier to have formed the ice-piles of the Rhone-valley, which at the Jura, must have mounted over the valley-bottom about 2000 feet, and which must have extended below to Soleure. We should arrive at still more striking conclusion, were we to apply the glaciers theory to the Scandinavian blocks, and yet it is scarcely allowable to explain such similar appearances as occur in North Germany and Switzerland, by two altogether different theories. What if in the hill country, at the foot of the glacierless Himalaya, the phenomenon of erratic block should reappear? Several accounts seems to establish the fact beyond a doubt.

We can avoid a part of these difficult questions, if we assume with HH. Agassiz and Schimpfer a general ice-covering of the earth, a freezing of the water in seas, lakes and streams from the poles to the equator. On the frozen inland sea, which thus in part overspread Switzerland, the Alpine fragments might have been slid to the Jura and to the slopes of the outjutting molasse hills, and in the same manner the Swedish blocks could have been shoved across the Baltic. The sudden occurrence of this ice-epoch was the cause of the destruction of the antediluvian animal races and vegetable species, of which not a single sort has survived to our time: and thus even in the earlier geological epochs, the periods of heat and life have been interrupted by periods of freezing and death. This originally Indian view of nature is capable of taking a very poetical form; and Hr. Schimpfer has given us a specimen of it. It looses, moreover, with the sword of Alexander to be sure, several of the most ravelled knots in Geology and Paleontology, but to make it harmonize with facts and with the prose of physical investigations, is a problem which far surpasses at least my powers,—the striking relations between the dispersion of the blocks and the shape of the vallies, which must ever lie at the foundation of any satisfactory theory, are left in the one lately proposed unregarded and unexplained. We see not how the blocks could have alighted, as they often have done in great numbers, behind outjutting hills, or pressed in upon the sides of the vallies; why, farther, their zone rises so high on the Jura opposite the Rhone-valley, and then towards Soleure gradually sinks down till it reaches the present valley-bottom; wherefore in the narrows of the vallies, the blocks are altogether wanting, while on the contrary in the wide portions they occur in the greatest number. But still more difficult is it to see from whence this periodical freezing, this alternation of heat and cold, of life and death, could have been derived. Not from a change of internal heat, for we know from Fourier, that at present, the influence of the internal heat upon the temperature of the surface scarcely amounts to $\frac{1}{3}\frac{1}{0}^{\circ}$ *c.* The warmth in which we live, and which remains constant at different depths of the ground according to latitude, and also agrees with the mean annual warmth of the atmosphere, is almost exclusively an effect of the sun. We might accordingly be referred to a periodical change in the intensity of solar heat,—a problem, with which Herschel

has recently busied himself without being able to find any ground, in all the depths of astronomy, for a greater change of annual heat than at the highest from 3° to 4°, and besides this change could only have come on very gradually, and could never have produced a sudden destruction of all organic nature. Still less do we find in the unequal temperature of space surrounding the earth, as assumed by Poisson, an explanation of the cause of these changes of heat and cold in terrestrial bodies; for, while a considerable increase in the coldness of the space in which the earth moves, would indeed produce a greater dissipation of the warmth of the earth, a lower temperature of the polar nights and more rapid loss of heat in our nights, it could scarcely be the means of freezing over all the bodies of water on its surface; and furthermore, these changes could only after a long space of time exert an influence—and that a very gradual one—on the annual temperature and organic life. We are thence peremptorily referred to hypotheses to account for that change of temperature, but hypotheses are justly regarded as unproductive, and, although they played an important part in the geology of the last century, yet certainly physical inquirers, who do so much honor to our age as HH. Agassiz and Schimper, will again and again visit the smooth worn rocks before they resort to this extreme expedient, and repeat the question to themselves and others, whether this polishing could only be the effect of ice, or whether every possibility is cut off, that they may have been produced by water currents, as previous to their labors was generally believed.

## II. *On two new Cobalt Minerals, from Modum in Norway;* by Hr. Prof. Dr. Wöhler, (with a note by Prof. Shepard,) from a letter to Hr. Dr. Blum.

We were too late with our examination of the new Modum Cobalt minerals, which you gave me last autumn. My analysis of them had been completed for some time, and I was about arranging the results, when I came across an acticle by Scheerer of Modum, in the last number of Poggendorff's Annals, where the same minerals are accurately and fully described.* Scheerer's

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* The cobaltic-arsenical-pyrites here mentioned, is described by Scheerer, as occurring in two varieties; one of which is crystallized and compact, and as having

analysis agrees quite exactly with mine, and leads to the same formula of composition. The arsenic-pyritical one has exactly the same form as the arsenic-pyrites, and is distinguished from it by a reddish color resembling cobalt-glance; points it directly to the composition of arsenical-pyrites, wherein a part of the iron is replaced by a quantity of cobalt varying in different individuals. From the crystals examined by me, I found the following compositions:

| | |
|---|---|
| Iron, | 30.9 |
| Cobalt, | 4.7 |

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the exact mispickel lustre and crystalline form, even to the streaking of the prisms. Sp. Gr. = 6.23. The analysis of crystals from two to three lines in length gave

| | |
|---|---|
| Sulphur, | 17.57 |
| Arsenic, | 47 55 |
| Iron, | 26.54 |
| Cobalt, | 8.31 |
| | 99.97 |

It would appear moreover, that the proportion of cobalt varies with the size of the crystal,—the larger the crystal, the smaller being the content of cobalt. SCHEERER supposes that its presence is not attributable to a mechanical source, but that it aids in forming a strictly chemical compound, inasmuch as the cobalt replaces the iron. He adds some account likewise of the geological position of the ore with reference to the occurrence of the cobalt mine of Skutterud. This last forms a vertical bed, or stratum whose direction is north and south, and terminates suddenly at the southern declivity of a mountain. Following the direction of this stratum nearly a mile, there is found on the opposite side of the Storcte river, the cobaltic-arsenical-pyrites bed, having the identical arrangement with that affording the cobalt glance. It would hence appear that the cobaltic stratum had supplied cobalt to that containing the mispickel as long as the metal held out.

The other variety has a tin or silver lustre, and a Sp. Gr. = 6.78. It occurs compact, with a conchoidal fracture, and a more or less distinct tesseral cleavage: also in single crystals exhibiting octahedral, cubic rhombo-dodecahedral and icositetrahedral faces. According to SCHEERER, it contained,

| | |
|---|---|
| Arsenic, | 77.84 |
| Cobalt, | 20.01 |
| Sulphur, | 0.69 |
| Iron, | 1.51 |
| Copper, | in traces. |
| | 100.05 |

BREITHAUPT has described this ore under the name of *Tesseralkies*.—POGGEND. *Ann. d. Phys. B. XLII, S. 546 ff.*

The first mentioned ore here described, is without doubt, the same substance which was noticed at Franconia, N. H., in 1824 by Dr. J. F. DANA of Dartmouth College, (Vol. VIII, p. 301, this Journal,) and subsequently in 1833 by Mr. A. A.

| | | | | | |
|---|---|---|---|---|---|
| Sulphur, | - | - | - | - | 17.7 |
| Arsenic, | - | - | - | - | 47.4 |

Scheerer found in two crystals 8.3 and 6.5 parts of cobalt.

We may name this spieces to distinguish it from the common Arsenic-pyrites, cobalt-arsenic-pyrites.

In all the crystals examined by me, a circumstance was remarked, which Scheerer has not mentioned, that the apparently purest and best formed crystals were more or less penetrated with clear crystalline quartz, the quantity of which in some specimens made up almost a quarter of the weight, in which case the internal structure could be seen on the outside. This commingling remained in all the crystalline portions, even when the whole crystal was dissolved in aqua regis. Besides, there remained small black spangles, still undissolved, which had altogether the appearance of graphite, and are in fact nothing else. I have also observed in this undissolved residuum still a third mineral, in very hard, brownish yellow, but quite microscopic crystals, which is certainly not quartz, but nothing could be determined concerning its nature.

The second mineral, with limewhite color mingled with lead gray, very definitely distinguished from that of arsenical-cobalt, and which occurs both compact with scaly grooves and beautifully crystallized in tesseral forms, the crystals oftener growing together with crystals of cobalt-glance, is arsenical-cobalt with $\frac{1}{3}$ more arsenic than usual. According to my analysis, it contains,

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Hayes of Roxbury, (Vol. xxiv, p. 387, this Journal.) Dr. Dana describes it as occurring in crystals analogous, if not identical with those of mispickel; and Mr. Hayes found their Sp. Gr. = 6.214, according to the analysis of the latter it contains,

| | | | | | |
|---|---|---|---|---|---|
| Sulphur, | - | - | - | - | 17.84 |
| Arsenic, | - | - | - | - | 41.44 |
| Iron, | - | - | - | - | 32.94 |
| Cobalt, | - | - | - | - | 6.45 |
| | | | | | 98.67 |

Loss partly iron.

Mr. Hayes proposed for it, the name of *Danaite.* Henry examined and described numerous forms of this ore from Franconia (see my treatise.) I perceive no sufficient reason for separating it from mispickel, with which it agrees in every respect save in the substitution of a small per-centage of cobalt for iron.

The second variety of cobalt ore, described by Scheerer and Wöhler does not appear to differ from the normal varieties of smalentine (*arsenical-cobalt.*)

C. U. Shepard.

| | Crystalline. | Compact. |
|---|---|---|
| Cobalt, - - | 18.5 - - | 19.5 |
| Iron, - - | 1.3 - - | 1.4 |
| Arsenic, - - | 79.2 - - | 19. |

If we assume the trifling unessential commixture of iron to be a substitution for cobalt, then this composition corresponds to the formula $Co\ As^3$, a combination, which must contain according to estimate 20.74 parts of cobalt and 79.16 of arsenic.

The name proposed by SCHEERER for this mineral, arsenic-cobalt-pyrites, appears to me in other respects little appropriate.

It is a striking circumstance that neither of these minerals contains nickle, which is elsewhere so constant a concomitant of cobalt; at least, it must have occurred in so minute a quantity as not to be observed in the small portions of the minerals subjected to analysis.

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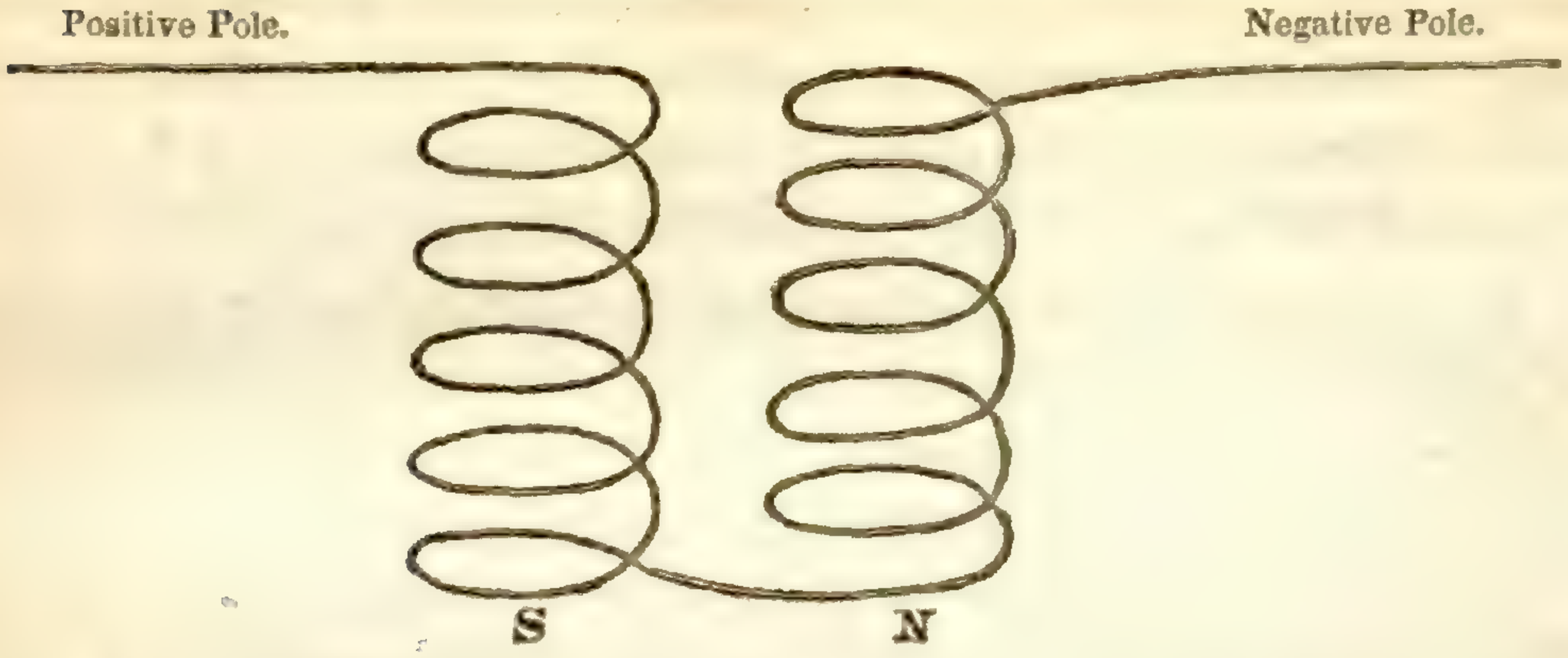
ART. VI.—*A New Method of Making Permanent Artificial Magnets by Galvanism;* by J. LAWRENCE SMITH, Student of the Medical College of the State of South Carolina.

EVER since galvanism has been known to produce magnetism especially under certain forms of apparatus, it has been a great desideratum to retain permanently, the great power that is generated within the limits of a few square inches of metal.

A few years since, having seen what an intense degree of magnetic force could be generated in a bar of soft iron, by passing galvanic currents around it; the idea (very natural to most persons witnessing the same experiment) occurred to me, whether this magnetism could not in some manner be retained; I was aware that so long as soft iron was made the agent it could not; and if tempered steel was used a difficulty would also present itself, and it was not until about eight or ten months since that the following experiments were put into operation. The object that I had in view, was to substitute for the iron used in the electro-magnet, red hot steel and cool it suddenly.

A few feet of copper wire were coiled as shown in the figure, the arrangement being such, that the galvanism in its circuit would generate north and south polarities, at the end of the re-




spective coils. The coils were varnished in order that they might be immersed in water, without any interruption taking place in the current of the galvanic fluid. The two extremities of the wire were attached to a battery, consisting of a single pair of plates, each plate of about twelve square inches. A horse-shoe of soft iron was then introduced into the coils to test their magnetic power; the iron was found capable of sustaining about one and a half pounds. After withdrawing the iron, a piece of steel, of the same shape, made red hot, was introduced and both steel and wire were plunged into cold water, and contrary to my expectation the steel was found to be but feebly magnetic. I then repeated the experiment, with this difference, that before cooling the steel, I united its two extremities (projecting below the ends of the coils) by a piece of soft iron, which by keeping up the circulation of the magnetic fluid, enabled me to procure a magnet of some power, that is to say, the steel used weighing one ounce, after undergoing this process, was able to sustain six ounces. It must be recollected that the instruments used were of a rude character, and that they could not create a temporary magnet, of more than one and a half pounds power. By this experiment it will be seen that one fourth the maximum power developed was secured permanently, but it is not to be supposed that in all instances the ratio of the power secured, to the power developed will be as great as in this, but I believe if proper proportions be observed in the steel used, there will be an approximation to this ratio, even when the magnetic force is of great intensity.

This method of making magnets may be of some practical utility, for the apparatus required is of the simplest kind, consisting merely of a few square inches of copper and zink, and a few

feet of wire; moreover the magnets produced are of a greater power in proportion to the generating energy, than those made by any other process, with which I am acquainted.

I will here mention an experiment which I have tried in common with others, of making magnets by attaching red hot pieces of steel to an artificial magnet, or to the temporary electro-magnet, and cooling them suddenly.

To an artificial magnet capable of sustaining eight pounds, I applied a piece of ignited steel weighing one ounce, semicircular in form, and immersed it in water; it was found capable of sustaining three ounces, only about one fortieth of the power used, and in no experiment, although many were made, was the ratio between the produced and the producing powers greater.

The reason of this great disproportion appears to be, that when the metal is raised to a red heat, magnetism is not easily induced in it, and that it is only when it arrives at a lower temperature in the cooling process, that it receives that magnetic virtue which it retains, and this no doubt also accounts for its inferiority to the first method mentioned—for there the galvanic fluid is made to circulate around the steel; and the current of the magnetic fluid is also kept continuous by the soft iron uniting the two poles.

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ART. VII.—*Remarks on the "Natural History of the Fishes of Massachusetts, embracing a Practical Essay on Angling;* by JEROME V. C. SMITH, M. D." Read before the Boston Society of Natural History, March 20, 1839. By D. HUMPHREYS STORER, M. D.

MY report upon the Fishes of our State having been presented to the chairman of the Zoological Commissioners, I feel that, as their ichthyological curator, a duty is expected of me by this society, before ceasing from my labors. In the year 1833, a volume entitled "Natural History of the Fishes of Massachusetts" was published by one of our number. To many persons, various inaccuracies contained in that work are at once obvious; by others, who have a slighter acquaintance with natural history, all is supposed scientific and true; while if errors really exist, it is certainly the duty of some one to correct them. I have thought it

would very naturally be expected of him to whom you have ever entrusted the care of the subjects upon which the work in question treats; and with this feeling, I have thrown together the following observations, which I now offer without further remark.

Commencing with the CARTILAGINOUS FISHES, the first ten pages are occupied with the history of two foreign species of *Petromyzon*, neither of which is found in our waters.

The *marinus* and *fluviatilis* should have been *Americanus* and *nigricans;* both of which were accurately described by *Le Sueur* in the "Transactions of the Philosophical Society" in 1818—fifteen years before the appearance of this work. These two foreign species are accompanied by figures copied from the German plates of *Strack;* and one or two points require to be noticed. It is well known that one of the characteristics of this genus is "its seven branchial orifices." Now it happens, that the engraver of Strack's plates thought that six would suffice, and accordingly omitted one in his figure. The American copyist, while he has attempted to exhibit the very attitude of the fish, has carefully followed his original, and the specimen before us is minus a branchial hole. The German did however continue the dorsal fin to the caudal, as is natural. The plate before us represents it as terminating at some distance in front of that fin.

The plate of the second species exhibits in Strack the true number of branchial openings; this copy has but five!

I suspect that foreign ichthyologists will scarcely pardon the presumption which would assert that these two species, which are described as distinct by Linneus, and have been thus acknowledged by all succeeding naturalists, "are to all intents and purposes the same fish."

The thirty four following pages contain the order SELACHII. In the prefatory remarks to this order, Dr. Smith observes, that the male shark may at once be recognized by the appendages to the ventrals, though he says "their use is totally unknown." Had he consulted standard works on the subject, he would have found that these appendages were called "*claspers;*" and knowing that the female did not possess them, their *use* might without much stretch of the imagination be inferred.

Eight species of sharks are here catalogued. The *Scyllium canicula* and *catulus* I have never seen, nor heard of, on our coast,

They have undoubtedly been mistaken for the *Squalus canis* or rather *Spinax acanthias—picked dog fish.*

Eight pages are appropriated to the *Carcharias vulgaris—white shark;* and its history is illustrated by a figure from Strack, while its appearance in our waters remains to be proved.

The *Carcharias glaucus—blue shark*—is evidently confounded with the *scyllium punctatum—mackerel shark*—a common species with us.

A species of *Zygæna* is found in our waters; but as we have no proof given us of its being the *vulgaris*, our species must be seen and described before it is acknowledged to be that species; and before we can receive the assertion in the pages before us, that "scarcely a season passes by, in which fine specimens are not taken in the vicinity of Nahant, about the Cape, &c." To be sure, we are told that "but a little time since, a sailor offered one, recently caught, for sale, which he wheeled through the streets of Boston on a barrow, attracting crowds of people who gazed upon it in perfect wonder;" but it was not the specimen of which we have a figure, surely, which created such surprise in this good city, because this is a copy from a German plate!

Of the species here registered as *Selache maximus—basking shark*—I have not been able to obtain the slightest information, and have no doubt that it is the *Somniosus brevipinna*, (Le Sueur) *nurse or sleeper*—described from a specimen taken by the fishermen at Marblehead.

That a species of *Torpedo* exists on our coast, we have undoubted authority for believing; but as no naturalist has as yet seen it, the species remains to be distinguished more definitely. We have here an inaccurate figure of the *Torpedo vulgaris* copied from Strack to illustrate our fish, when that species has been much more correctly exhibited by Pennant in his "*British Zoology.*"

*Strack* is again called upon for a plate of the *Raia clavata-thornback.* The species called *thornback* in Massachusetts, I have not had a proper opportunity to examine, having never seen more than one specimen, and that previous to my determination to describe our fishes from recent specimens; if I am not in error, however, it will prove to be the *Raia radiata—starry ray.*

A species of *Trygon* is occasionally seen on our coast; but its characters have not yet been pointed out, so that it is premature to

introduce it here with a plate of the *pastinaca*—the *European species*—especially as other species of this genus have been found on the coast of Rhode Island, to which this is much more likely to belong.

An elaborate account of the *Sturgeon—acipenser sturio*—accompanied by a figure, follows the SELACHII: the Massachusetts sturgeon is the *sturio oxyrinchus.*

Four species are here included in the PLECTOGNATHI. The *aluteres monoceros* proves to be a new species to which I have affixed the name of "*Massachusetensis*" in my report to the Governor: neither the *ostracion triqueter* nor *bicaudalis* have I ever heard of on our coast. The specimen which Dr. Smith supposed to be the latter fish, is a new species to which I gave the name of *Yalei*, in a communication read to this society in 1836.

Under the head of *Tetraodon turgidus—swell fish*—we find the following sentence, which cannot be passed over unnoticed, however unwilling we may feel to write a line of unmixed censure. "The only apology we can make for not having dissected one of them with reference to explaining their internal organization, is the poor one, that there has not been time since the commencement of this essay." Here we see an author voluntarily coming before the public, dedicating his labors to a distinguished LL. D., and offering as an apology for a neglect so palpable that his own conscience accuses him, that he *needed time!* It is humiliating enough for him who has but a certain time allowed him in which to perform a duty, to be compelled to offer such an excuse, although he has a right to expect the circumstances of his case will be considered; but, when an individual to consult his own convenience, chooses to publish a superficial treatise with his name prefixed as its responsible author, such an apology cannot be received by naturalists—regardless as he appears alike of his own reputation and the true interests of science.

Although in the LOPHOBRANCHII, the *Syngnathus typhle* is described, and illustrated by a figure, I have not heard of its having been seen in Massachusetts. Two species have been sent me by correspondents, both of which are new, and will appear in my report.

Having reached the order MALACOPTERYGII ABDOMINALES, in the genus *Salmo*, three species of trout are introduced, the "*trutta*, and "*fario*," and "*hucho*," while the only one I have been

able to learn any thing respecting, after two years' labor, the "*fontinalis*," is omitted altogether.

Nine pages are devoted to the "*Clupea harengus*"—European herring; our species is the "*elongata*," described by Le Sueur in the first volume of the "*Journal of the Academy of Natural Sciences.*"

Upon page 165, we have a figure of the "*Esox lucius*"—*pickerel*—whose history is spread over nearly twelve pages. Our fish, is the "*reticulatus*," which cannot for a moment be mistaken for the European species, by any person of common observation: we are here told that Dr. Williams, author of the history of Vermont, states that the pike bears in that state the name of *muschilongae*:—the *maskinongé*, is the "*esox estor.*"

I have thought that little if any change was produced in the color of our species by age; the largest I have ever seen was as brilliant as smaller specimens. I suspect the brightness of their coloring depends principally upon the locality; thus, those brought from a pond in Brewster upon the Cape, which has a sandy bottom, are perfectly beautiful; while those caught at West Cambridge Pond, and others in this neighborhood, are far less attractive in their colors.

But one species of the genus "*Belone*," the "*truncata*," (Le Sueur,) is found on our coast; this however is here omitted, and a foreign species is introduced, with a figure as usual from *Strack.*

That one or more species of "*Exocetus*"—*flying fish*, are occasionally taken on board vessels in our waters is undoubted; but that the "*mesogaster*" is one of these species, is far from being proved.

The "*Cyprinus crysoleucas*" could not have been known to the writer of the volume before us: he says "Though we have seen individuals two inches in length, they are oftener less than one." Of great numbers which have fallen under my notice, the average is from four to six inches.

The "*Cyprinus oblongus*" and "*teres*," I have not seen: the writer seems not to have known that there existed more than one species of *sucker*; for he says, "from the earliest period of our boyhood, we have been familiar with the fresh water sucker, a lazy, still fish, of a dingy color," &c. &c.

Under the head of "*Cyprinus teres*," the writer speaks of a fish which was taken by the keeper of the Boston light house in

a *lobster-pot*, and calls it the *sea-sucker ;* he observes, it "has a mouth precisely like the fish above described," &c. ; and from the fact of its being introduced here, we infer it was considered a neighboring species. The fish here spoken of, formed a part of the collection of fishes purchased of Dr. Smith, and is the "*Umbrina nebulosa*" described and figured by Mitchill in his "*Fishes of New York.*"

The author is guilty of a gross and altogether inexcusable error in the following species ; he speaks of the "*Abramis chrysoptera*"—*bream :* now the common European bream is the "*Abramis brama*," and as yet we know of no "*abramis*" with us. The "*Pomotis vulgaris*" is generally known as the *bream;* it is the only species I ever heard of as being called *bream* in New England, and as the "*Pomotis vulgaris*" is not mentioned in the pages under examination, the inference is irresistible that what is here called "*Abramis chrysoptera* is the "*Pomotis vulgaris.*" So that we have a foreign fish catalogued as being found in our waters, which is included in the family CYPRINIDAE, order MALACOPTERYGII, instead of our own beautiful species, to receive which, a genus was formed by Cuvier, and included in his family PERCOIDES, order ACANTHOPTERYGII, showing conclusively, that the *common name* being given, the *scientific name* of a foreign species is attached, whose common name was the same as ours.

Respecting the four following species, I have only to say, they are all unknown in Massachusetts : the fishes which are known as the "*Roach*" and "*Dace*" are not the European species "*Leuciscus rutilus*" and "*vulgaris*," but undescribed fishes.

The "*L. alburnus*" and "*cephalus*" I have never seen ; and as no foreign fluviatile species has as yet been met with in our state, I feel it is just to doubt their existence. That many of the CYPRINIDAE would thrive in our waters if transplanted to them, may reasonably be concluded from the rapid increase of the "*Cyprinus auratus—gold fish*, in our ponds ; and my friend, Rev. J. E. Russell, of Salem, informs me that an English gentleman residing in Newburgh, New York, has stocked his ponds with the *English carp*—"*Cyprinus carpio*," from a few he imported.

On page 189, is a figure of the "*Silurus glanis*," an European fish, copied with considerable accuracy from Strack's plates, de-

signated as the "*Horn pout*," and described as our fish, which belongs to a distinct genus. Dr. Smith observes, "there are two species (of Silurus) in this vicinity. I never heard of one.

From a careful inspection of our market for two years, and a constant intercourse with fishermen during that period, several of whom for a long time were *bank fishermen*, I am satisfied the Bank cod—"*Morrhua vulgaris*," is not taken in our waters. I have accordingly described our species in my report under the name of "*M. Americana.*"

The "*Merlucius vulgaris*"—*Hake*, is called by our fishermen the "*Whiting*;" our author, learning therefore that the *Whiting* was found on our coast, has supposed of course that it was the *European Whiting*, and we accordingly have here an account of the "*merlangus vulgaris*," which is not seen with us.

Our "*Pollock*" is not the European fish, but the "*purpureus*" of Mitchill.

What can be more amusing than the remarks which we find under the genus "*Raniceps.*" The "*Blennius viviparous*" and "*Raniceps trifurcatus*" are here side by side as synonymes of the same fish—*Blenny.* The one belonging to the order Acanthopterygii, family Gobioidae; the other, to the order Malacopterygii, family Gadidae. This is not all; a perfect burlesque of the "*viviparous blenny*," appears in the form of a figure copied from Strack, with these remarks accompanying it; "on looking over that splendid series of German lithographic plates of fishes, by Dr. Strack, 1828, an exact figure even to the coloring was noticed, which truly exhibits the blenny of the harbors of Massachusetts, and must therefore, we strongly suspect, have been drawn from the American blenny." After reading the above, what can the student think, when we tell him that *this fish* was never found in our waters; that *our blenny* is totally unlike the "*viviparous*," and instead of being caricatured in "the splendid series of German plates," was, years ago, figured by Professor Peck, in the American Academy's Transactions, as the "*anguillaris*," formed by nature.

Determined to have a "*Raniceps*," we find that Dr. Smith has here introduced the "*blennioides*;" the individual which he speaks of, as "a cream colored fish truly disgusting in appearance," was purchased of him by this society, and proves to be a specimen with *the cuticle abraded*, of what he upon page 243

calls incorrectly "*muraena conger*;" but more of this in its appropriate place.

Five species are mentioned in the family "PLEURONECTES," but one of these, "*Hippoglossus vulgaris*"—*holibut*, is found on our coast.

Under the head of "*Platessa vulgaris*," our compiler gives the appearance and habits of the *European flounder*, and says "it is one of the most common fish in Massachusetts Bay;" and for a *figure*, he introduces a wretched copy of Strack's plate of the "*P. vulgaris*"—*plaice!*

Two pages beyond, we have a copy of the "*flesus*"—"*flounder*, from Strack, described as the "*plaice*; and both the *flounder* and *plaice* described as the "*Platessa vulgaris*." It will at once be perceived that these two copies of foreign fishes should be transposed: the plate on page 214 should take the place of that on page 216, and vice versa. Neither of these species however, the "*vulgaris*" nor "*flesus*" is found with us.

Reference is made on page 216, to a species which is called the "*American turbot*," supposed to be the "*European pearl*," it is the "*Rhombus aquosus*"—"*watery flounder.*"

Neither the "*Solea vulgaris*"—"*Sole*," nor "*Rhombus maximus*"—"*Turbot*," were ever seen by any of our fishermen upon this coast; the opinion was so firmly established, that what is called in our market the "*turbot*" was the same as the *foreign turbot*, that I could not persuade the fishermen that they were not identical; it was only when two fine specimens were brought here the last season, of the *true turbot*, from the the coast of Ireland, that they were satisfied of their mistake; and even then, one of the most experienced of their number insisted that although they differed, the only difference was this, that wherever a *white spot* existed in the American fish, a *spine* took its place in the foreign species, and that opinion he still entertains, although our fish is oblong in its form, and the turbot is nearly circular.

The "*Cyclopterus minutus*" is probably the young of the "*vulgaris.*" Although the "*Echeneis remora*," is here introduced with a plate from Strack, it has not yet been found in our waters.

Twenty pages are devoted to the "*anguilla vulgaris*" and "*muraena conger*," neither of which is found on the coast of New England. The former has been mistaken for the "*mura-*

*ena Bostoniensis*" of Le Sueur. The latter, is the species *uninjured* which when *defaced*, Dr. Smith called "*Raniceps blennioides*," it is evidently a new genus, which, from the appearance of concealed spines distributed over its head, I have called "*Cryptanthodes*"—and given the specific name of "*maculatus*" on account of its mottled surface, arranging it in the family "BUCCAE LORICATAE, *mailed cheeks.*"

Our writer seems to have been ignorant of the fact, that the "*Anarrhichas lupus*"—"*Cat fish*," was used as food among us. Many of our fishermen prefer it to any other species. I have eaten it at my own table, and should never wish a sweeter or more delicate meal than that afforded by a young cat fish. It is a little singular, that instead of Pennant's plate of this species having been copied, which is quite good, and within the reach of all, Strack's plate which is very incorrect, making the anal fin to appear as high as the dorsal, should have been preferred.

Upon page 254, "*Labrus tautoga*" should be "*L. Americanus*;" we read here that "the Boston market is but poorly supplied with them; whenever they are for sale, it seems to be the result of accident." The two last years our market has been *glutted* with them, throughout the season in which they are taken.

Upon page 259, we have a description of the *cunner*, or *marine perch* as it is often called; and it is surprising that after the author observes, "since the commencement of this little volume, no one species has given us more trouble and perplexity in the classification than this;" to find it arranged in a wrong genus, with the sage remark, "**to all appearance the *perch* or *cunner* is** the *tautog* in miniature; and if it were black it would be supposed to be the young of that fish!" And this too, while the preoperculum of the former is strongly denticulated throughout, and the edge of that of the latter is perfectly smooth!

Among the "*Labroides*," we also find the "*squetee*" arranged as a "*Labrus*," instead of being placed in the family "*Scienoides*"—genus "*Otolithus.*"

Upon page 263, Dr. Smith probably refers to the "*Centropristis nigricans*," when he speaks of the "*Perca varia.*"

The next eleven pages are occupied with descriptions of nine species, neither of which is found in Massachusetts. We have

neither a "*Scorpaena*," nor a "*mugil*," nor a "*surmullus*;" and yet here we find an account of each.

If instead of copying upon page 273, a plate of the *European perch*, from Strack, our only species of "*Perca*" the "*flavescens*" had been delineated, while the writer before us had avoided an error, he would have conferred an obligation.

The "*Bodianus leucos*"—"*rufus*"—and "*pallidus*" are all unknown fishes to me.

Six pages are devoted to the "*striped bass*"—"*Labrax lineata*," here incorrectly called "*Perca labrax*"—the *European species*. Our writer observes, "one old fashioned bass only, is known to us from Cape Cod to Maine:" if he will visit Boston market in any of the spring or autumnal months, he may see another very common and pretty species of bass—the "*mucronatus*"—the "*smaller American bass*," called by our fishermen "*Pond perch*."

The probability of the "*Uranoscopus scaber*" being found here, may be inferred from the following remark of Richardson in his "*Fauna Boreali Americana*"—the "*Uranoscopus scaber*," is common to the Mediterranean and Indian Ocean, without having been detected in the Atlantic."

We are told by the writer that he had not found the "*Trigla lineata*" in Massachusetts—we have no "*Trigla*" on our coast; but the *Prionotus strigatus*," incorrectly called here "*Trigla lineata*," is common at Martha's Vineyard.

Four species of "Cotti"—*sculpins*," are here spoken of; one of which, the "*gobio*," we are told, "is universally known all over New England;" another, the "*quadricornus*" "is found along the whole coast;" the "*scorpius*" is illustrated by a figure from Strack; and with the "*cataphractus*" "the fishermen are particularly familiar under the name of *ruper sculpin —horn sculpin*," &c. Not one of these fishes is ours—the "*aeneus*," and "*Virginianus*" and "*Groenlandicus*" are common along our entire sea-board, but not one of the above mentioned species did I ever hear of being taken.

The "*Batrachus grunniens*" is mistaken for the "*variegatus*" of Le Sueur.

Under the genus "*Lophius*," we have an account of the "*piscatorius*;" our writer tells us he was fortunate enough to obtain one, the body of which, was *four feet in length*, and "when

the jaws were open, it could receive a morsel as large as a man's head." What excuse then can be offered for his illustrating this species with the plate of a distinct fish—a foreign species—belonging to another genus, which grows only to the length of ten or twelve inches! the "*Chironectes histrio.*" Such negligence cannot be overlooked; we have the "*piscatorius*" in our waters; or had the author preferred, as he ever seemed to have done, to copy from figures rather than from nature, he could have found a plate of it in any work on Ichthyology.

I have no doubt that Cuvier is correct in considering the "*Scomber grex*" and "*vernalis*" as the same species.

Neither the "*chrysos*" nor the "*plumbeus*" do I know.

Eight pages are occupied with the "*Scomber scomber*"—"*European Mackerel*;" it is not found on our coast.

Respecting the "*Surmullet,*" I would only introduce a single remark of Dr. Richardson. "*Mullus*, in its geographical distribution, is confined to the Black Sea, Mediterranean, and European Atlantic, including the Baltic."

Upon page 307, we are told that "the spinous fins (of the *Tunny*) have a yellowish tinge;" as the *finlets* are the only portions of the fish, which are yellow, they are probably intended.

The "*Centronotus ductor*"—"*pilot fish,*" may possibly be found within the waters of Massachusetts, although I have never been able to procure one.

The "*Zeus faber*"—*common dory*, I have never seen, nor heard of as being found in our waters.

Although we are told in the volume before us, that the "*Chrysotosus luna*"—("*Lampris guttatus,*") "has been taken within a day's sail of Boston;" and Richardson in his "*Fauna Boreali Americana*" accordingly observes under the head of this fish, that "Dr. Smith enumerates it among the fish of Massachusetts;" I have never been able to learn any thing regarding it, from any of the fishermen, and therefore, although as it is a *northern species*, further investigation may establish its existence in our waters, I should be unwilling to consider the point as proved from the notice here referred to.

Dr. Smith, tells us *two* species of "*Sword fish*" have been discovered: *Cuvier* knew but *one.*

The "*Seserinus alepidotus*" is here catalogued in the family "SQUAMIPENES," instead of the "*Scomberoides,*" as it should have

been: the only species described, is an inhabitant *only* of the Mediterranean and Black Seas.

Under the head of "*Fistularia*," we find the "*tabacaria*" illustrated by a figure from Strack; and our writer says, "had we not two excellent specimens of this fish taken near Holmes' Hole, its existence would not have been credited so far north of the Equator." One of these "*two excellent specimens*" belongs by purchase to this Society, and is not the foreign fish, but the "*serrata.*"

Thus have I taken a hasty review of that portion of the volume before us which treats of *distinct species:* the remainder of the work I have not referred to, determined to confine myself only to what appeared absolutely necessary to be noticed. The remarks upon the "*Anatomy and Physiology of Fishes*," and the "*Treatise on Angling*," are foreign to my purpose. The accuracy or errors of the *former*, may be ascertained by consulting any standard work on Comparative Anatomy; of the *latter* subject I plead entire ignorance.

A few words more and my unpleasant task is done. The 248 pages over which we have thus rapidly passed, contain notices of 105 species, of which 80 are foreigners, and but 25 are found in the waters of our State. Of these 105 species, 36 are illustrated by figures; of these 36 illustrations, but 9 accompany species which are found on our coast; of these 9 figures, 6 are copied from "*Strack's Plates*," and 3 from Mitchill's "*Fishes of New York!*" Of the 36 plates contained in this "*History*," not one is drawn from nature. If "the chief value of a written history is in its truth, and next in the evidences of its truth,"* what reliance can be placed in us as naturalists, when one of our number is allowed to publish such a work as this, and it is permitted to circulate for years without a word being said or a line written to point out its inaccuracies? Why should we wonder that Yarrell, in his "*History of British Fishes*," should really think that the "*Silurus glanis*" and "*Petromyzon marinus*" were found in Massachusetts, or that Richardson in his "*Fauna Boreali Americana*," guarded as he generally has been in receiving what is stated here, should *almost* believe that the "*Lampres guttatus*," and "*Clupea harengus*," and "*Merlangus vulgaris*," and

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* North American Review, No. 53, p. 439.

"*Echeneis remora*," were inhabitants of our waters, when not a doubt of the correctness of this compilation is expressed by an American ichthyologist?

I have studiously avoided noticing any of the numerous exaggerated stories which are so liberally distributed throughout the pages before us, feeling they could not deceive the naturalist, to whom alone I would address myself; but what can be thought of the assertion on page 75, that the "*Astacus Bartonii*"—*little craw-fish*, which measures from "the tip of the rostrum to the end of the tail two inches," and the "*Astacus marinus*"—*our common lobster*, are the same species! I will make no comments upon this statement, but beg permission to extract a few lines from the page referred to. "On some of the highest points of the Green Mountains between Massachusetts and New York, in those small basins of water which are formed between different eminences, lobsters are not only numerous, but really and truly formed precisely like those of the ocean; yet they rarely exceed two inches in length. The question at once arises, how came these animals in that locality, if the ova of the lobster were not conveyed there by some bird? The fresh water together with the climate of those high regions, has prevented the full development of these miniature lobsters, though in character, habit, and anatomical structure, there is the most perfect resemblance; and were the ova from the family on the mountain placed under favorable circumstances in the borders of the sea, we have no doubt that the progeny would be as large in one or two generations as any specimens which are exhibited from the ocean."

Such is the "*Natural History of the Fishes of Massachusetts.*" I have endeavored honestly to review it. Believing fully the remark of *Babbage*, "that the character of an observer, as of a woman, if doubted is destroyed,"* I have felt no pleasure in the progress of my examination; the duty has been performed for this Society, that when ridiculed for the publication of one of its members, they may be able to say, *we are aware that these errors exist; they have been pointed out by him who felt called upon to do so.*

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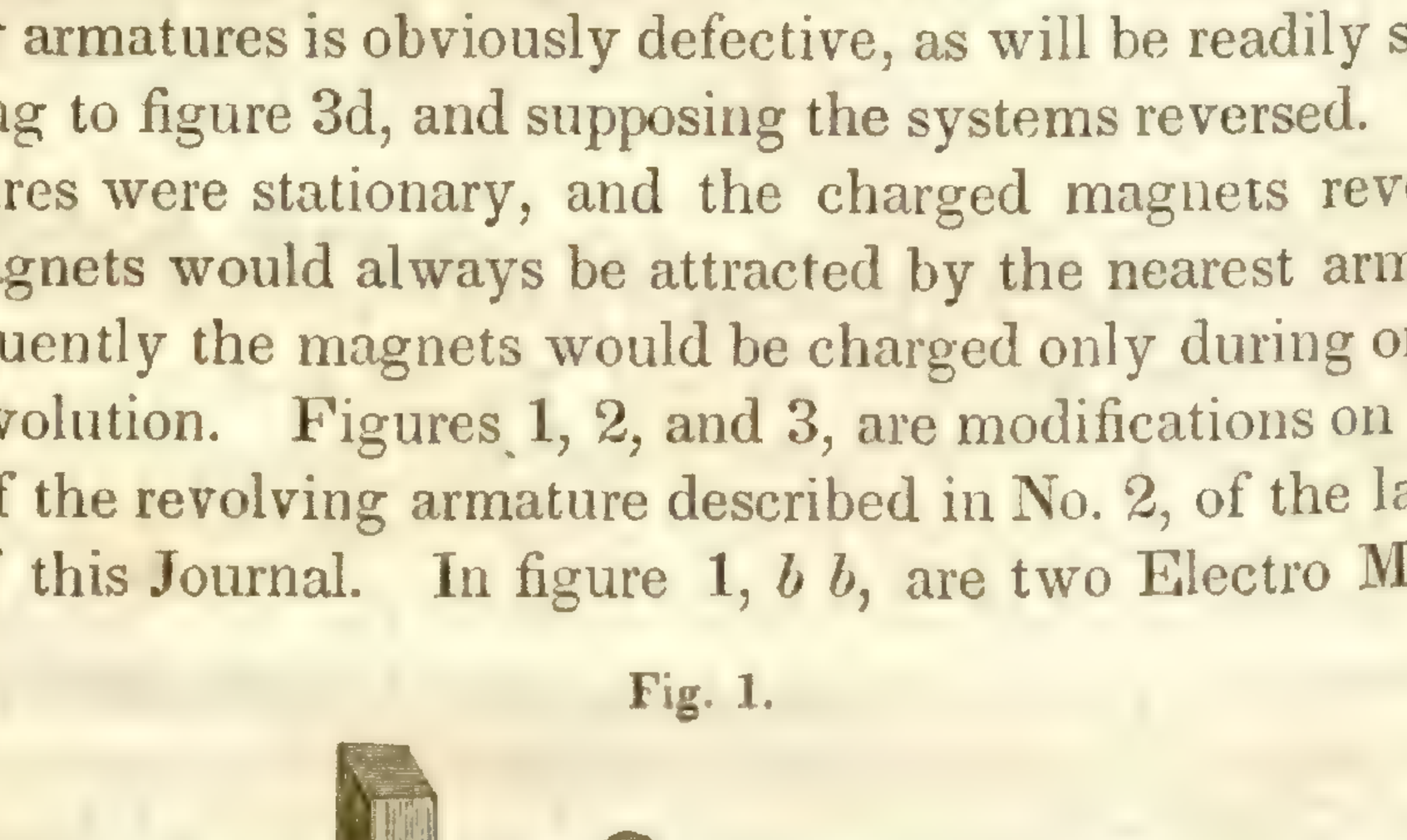
* "Reflections on the decline of Science in England, by C. Babbage." p. 182.

## Art. XVIII.—*Electro Magnetism;* by Charles G. Page, M. D., Washington, D. C.

In Vol. xxxv, No. 2, of this Journal, I described a revolving armature and mentioned that the plan admitted of enlargement only with the alteration of the mode of revolution. I must premise here, (as I have heretofore expressed myself,) that I do not suppose this power susceptible of infinite increase, and in giving these descriptions to the public, I am only selecting from the multitude of machines I have constructed, such forms as obviously economize a given galvanic power. A number of machines wherein the poles of the magnets were changed, and others where the poles were not changed, but both systems, the stationary and revolving, were rendered magnetic and non magnetic at intervals, have been laid aside as not worth describing. Another form wherein the magnets were made to revolve and attracted by stationary armatures is obviously defective, as will be readily seen by referring to figure 3d, and supposing the systems reversed. If the armatures were stationary, and the charged magnets revolving, the magnets would always be attracted by the nearest armature; consequently the magnets would be charged only during one half of a revolution. Figures 1, 2, and 3, are modifications on a large scale of the revolving armature described in No. 2, of the last volume of this Journal. In figure 1, *b b*, are two Electro Magnets

Fig. 1.




disposed at right angles to each other, and firmly secured to wooden pillars. Where it is practicable, the magnets should be

supported by wood, as every piece of metal of any kind surrounding a magnet, detracts from its action, by reason of closed currents excited by the disturbance of magnetic forces. For the action of closed currents see Vol. xxxv, No. 2, pages 254 and 5. The armature *a*, is mounted upon a brass shaft *e*, as I have heretofore shown by experiment that an iron or steel shaft detracts greatly from the inductibility of the armature. At *e*, firmly secured to the shaft is the electrotome or cut-off, the black portions representing the intersections of ivory or other non conducting material. Two pairs of plates (compound series) are connected by their poles with the cups *p p*. By the revolution of the armature the two magnets are charged in succession, and thus the action is maintained during the entire revolution.

Fig. 2.

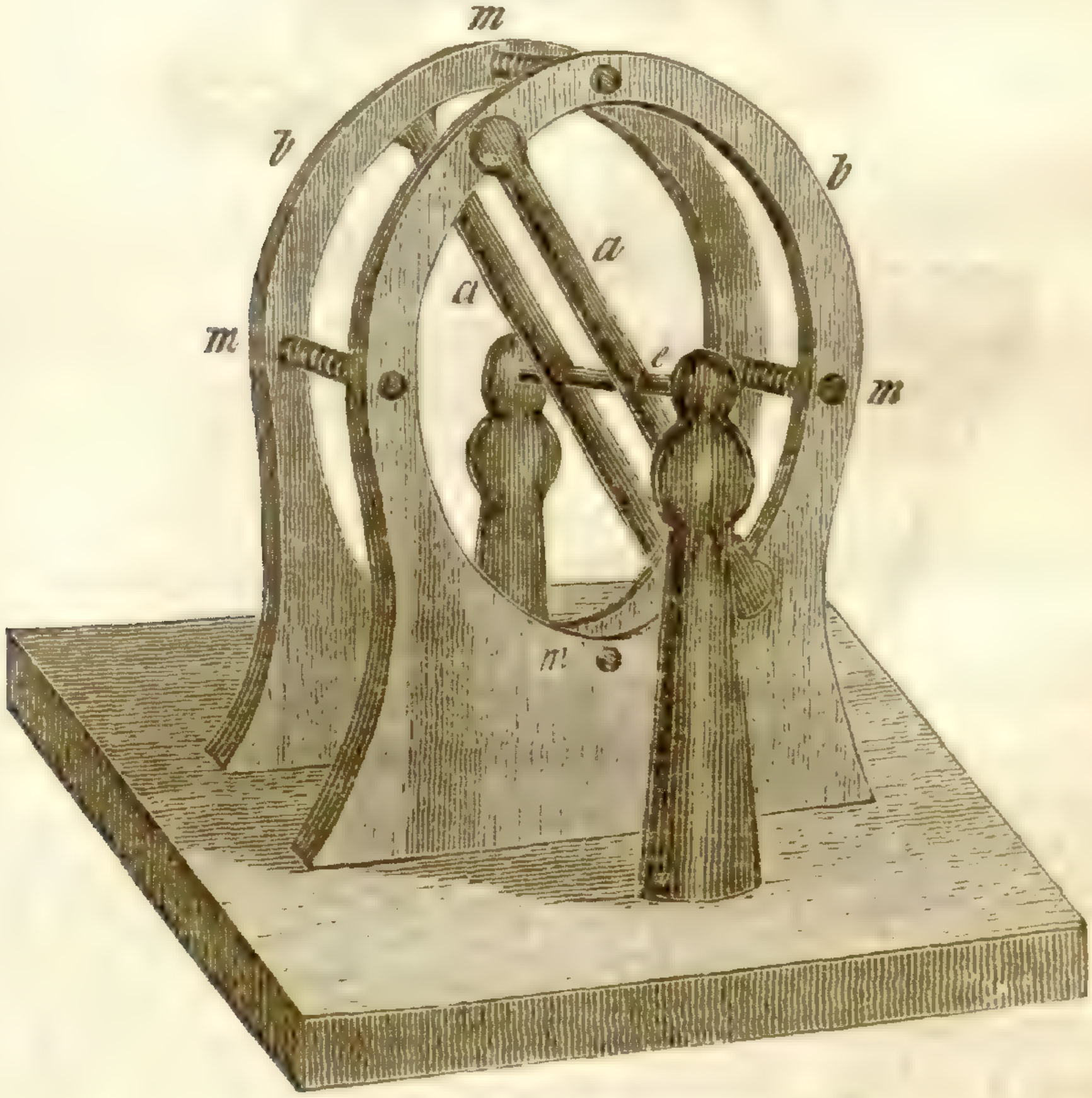
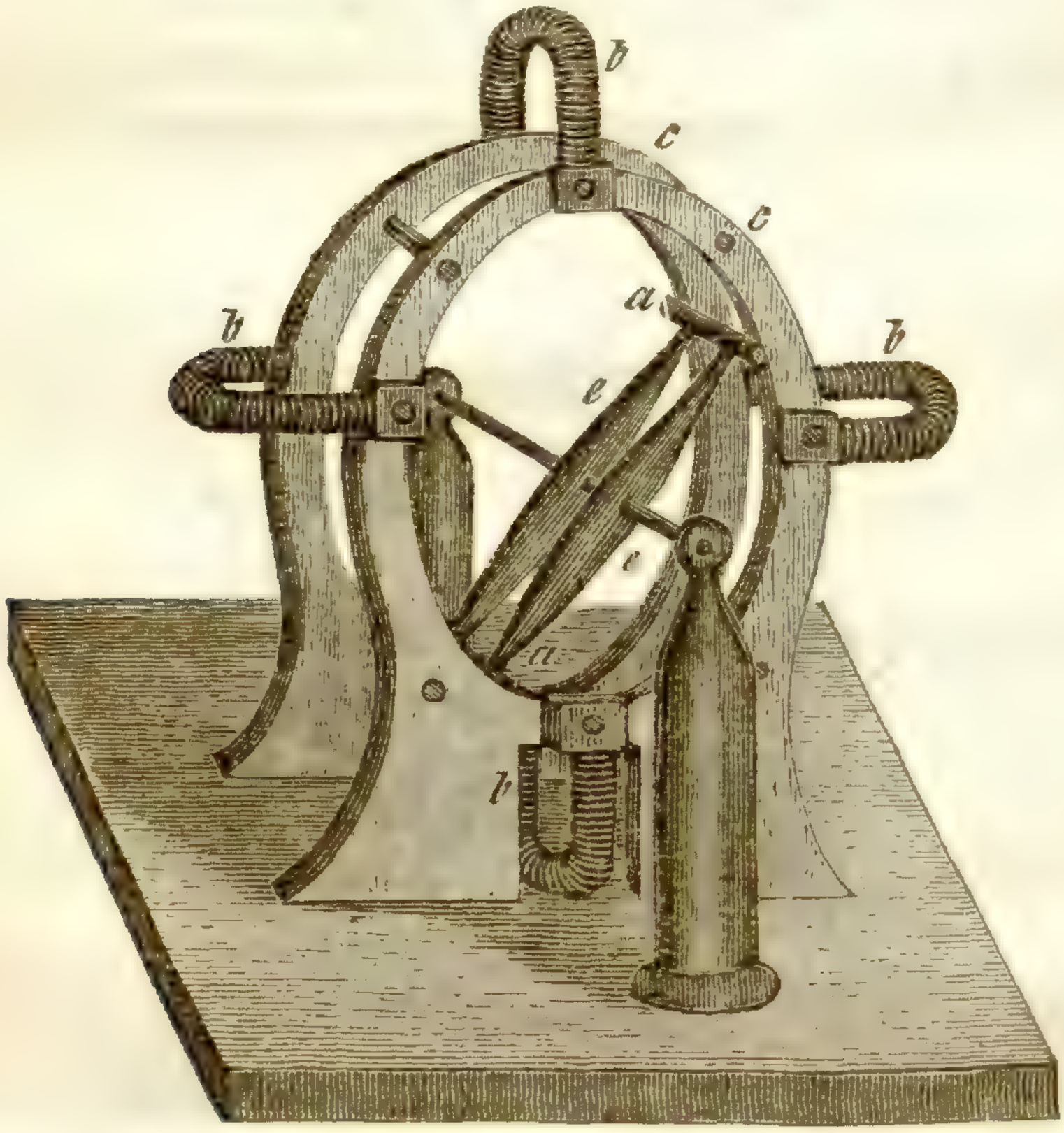



Figure 2, exhibits a machine of more simple construction than the last, or perhaps than any other. It possesses also the advantage of straight magnets much preferable to the U magnet. *b b* are wooden frames or braces supporting the straight magnets *m m*. *a a* are the two armatures upon the brass shaft *e*. The electrotome constructed upon the same principle as that of figure 1 may

be placed at *e*, and the wire connexions as before directed. This is at once a very beautiful and simple machine, but in order to realize its full power, the two straight magnets should be charged by separate batteries. It cannot be made very large with any economy, and the proportions should be very different from those seen in the figure; the armatures should be much shorter than the magnets.

Figure 3, represents a revolving armature machine, invented in the month of March, 1838.

Fig. 3.




The magnets *b b b b* are secured by brass screws to the braces *c c*. The armatures *a a* are attached to two arms *e e*, which in this case may be run upon a steel shaft. The electrotome is similarly constructed and placed, and the connexions similar to those of figures 1 and 2. This is the last of a series of experiments made with reference to this subject, and after much attention, I am inclined to give it the preference. Soon after this was invented, a machine of larger size was built by the subscription of several gentlemen in Boston. It contained eight magnets, four revolving armatures and the revolving system was one foot in diameter. Not being able to be present during its construction, some

errors were committed, and on the first trial it made only eighty revolutions a minute. The remodeling was delayed until further subscription should warrant the proceeding; and I regret to learn that the recent disastrous fire in Boston has destroyed the machine and batteries.

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## Art. IX.—*Observations on Electricity;* by Charles G. Page, M. D., Washington, D. C.

It is somewhat singular that the following fact has so long remained in obscurity, especially as the Franklinian theory has derived its principal support from the converse of this fact: "If a pith ball be laid in a groove on the table of the universal discharger, and a Leyden jar or battery be discharged in the direction of the groove, the ball will be propelled in the direction of the passage of the fluid, that is, from the positive to the negative." It must have happened, that in every case of repetition of this experiment, the jar was charged in the ordinary way, viz. the interior or *insulated* coating charged with vitreous or positive electricity; for it will be found that if the *insulated* coating be charged with *negative* or resinous electricity, the ball will be propelled contrary to the supposed direction of the fluid, that is, it will move from negative to positive. "If a card be placed upon the table of the universal discharger, and the wires or directors be brought into contact with the card on opposite sides, but at some distance from each other, the perforation made by a discharge between the points, will be found nearer the negative than the positive wire." By reversing the experiment the same error will be found in this statement. If the negative surface be insulated, the perforation takes place nearest the positive wire. The same correction will apply to the experiment with the flame of a candle between two cups of phosphorus.

Curious result from the configuration of the electric spark at the positive and negative surfaces. If a tapering jet from which issues a stream of hydrogen gas be applied to a conductor charged positively, the gas will be inflamed nearly every time the spark is drawn; but if the conductor be charged negatively, the gas will rarely be kindled, frequently requiring six or more applications before it succeeds.

During the month of October last, I made a number of experiments with a view to ascertain the utility of presenting points only upon one side of the plate in the electrical machine. My attention was called to this subject by a singular experiment shown to me by Mr. Daniel Davis, which for some time appeared rather enigmatical. A circular plate of glass was charged by movable coatings, and on removing the coatings, it frequently happened that both sides of the plate when presented to a charged electroscope, exhibited signs of the same species of electricity. After numerous repetitions with a very careful examination, it appeared that only the central portion of the negative side was charged negatively, while a considerable annular space exterior to this, was charged positively; the redundant positive electricity having forced or spread itself over the edge of the plate. On reversing the experiment and making the redundancy upon the negative side, the negative electricity appeared to pervade both surfaces as did the positive before. Some of our instrument makers have been in the practice of placing the collecting points of the prime conductor only upon one side of the electrical plate, finding that they answered better in many cases, than a row of points upon both sides, although no satisfactory reason has been given for this difference. After witnessing the above experiment, it occurred to me that the difference was owing to the facility with which electricity distributes itself upon glass, especially if it be not entirely clear and dry. Experiment fully confirmed my anticipations, and I was surprised to find to what extent the plate might be discharged by the application of a conductor to any part of its charged surface. The prime conductor having been removed, the plate was turned several times and the silk flap thrown back leaving both sides of the plate exposed in a highly charged state. The hand was then laid upon the plate at some distance from the edge and quickly withdrawn. On examining the plate not only the parts under and contiguous to the hand were discharged, but the whole of that portion directly opposite to the hand on the other side of the plate was found discharged to the same degree, although the distance over the edge of the plate was in some cases fifteen inches. It will be found that single or only two points on each side of the plate and near its circumference will succeed better than numerous points upon one side.

ART. X.—*Additional Account of the Shooting Stars of December* 6 *and* 7, 1838; *communicated* by EDWARD C. HERRICK, Rec. Sec. Conn. Acad.

VARIOUS observations made in this country on the shooting stars of December 6 and 7, 1838, were published in the 72d No. of this Journal. By recent intelligence it appears that this meteoric display was also noticed in distant regions.

1. Rev. Peter Parker, M. D. in a letter to my friend, Mr. A. B. Haile, dated Canton, China, January 12, 1839, (received here May 3, 1839,) after referring to the observations made there from 12th to 14th November, 1838, states the following important facts: "On the fifth of December, [1838, at Canton, N. lat. 23° 30′; E. lon. 113° 3′] however, the falling meteors were still more abundant, [than on the morning of November 14, 1838,] *one hundred and sixty* being counted in the space of one hour from eight and a half to nine and a half o'clock, P. M.; and *a few evenings after this they were much more frequent.* I have often kept a lookout since, but no recurrence has been witnessed." The Canton Register of Dec. 11, 1838, gives the following account of the same event: "With reference to the highly interesting meteorological observations taken on the 12th and 13th ult., we have been informed that a much more remarkable phenomenon was noticed on the evening of the 5th inst., when from half past eight to nine, *one hundred and eight* meteors were counted; and from nine until half past, *fifty two;* the moon and clouds then interrupted the view."

The number of observers is not stated, but it was doubtless insufficient to note all the meteors visible. The evening on which the meteors were most abundant at Canton was probably the *seventh* or *eighth.* The earliest observation after the *third* of the month, which the weather permitted us at New Haven, was on the evening of the *sixth,* about a day and a half later than the first observation at Canton.

2. The *London Times* of Dec. 11, 1838, contains a letter from Mr. George Jeans, a copy of which is here given, with the omission of a few unimportant remarks. "Yesterday evening, Dec. 7, as I was amusing the son of a friend in this neighborhood with a 42-inch telescope, the atmosphere being unusually good for

telescopic observations, and what light airs there were, being from W. N. W., we were surprised by the frequency of those meteoric exhibitions called *falling stars*. From 6 to 7 o'clock, five minutes rarely elapsed without one, and frequently several descended in quick succession, so that by estimation, I should think about *thirty* were seen in that time. But from 7 to 8, it was very seldom that a single minute passed without a meteor, and for a considerable time it literally rained [?] without any intermission. After 8 o'clock they became less numerous again, but still equal to what had been observed at first, till half past 9. Nor had they ceased between 10 and 11; and when returning home after midnight, though the moon was shining brightly, I counted several. They were not of one kind alone, but of all the species usually enumerated; nor did they fall from one part of the heavens only, but were widely diffused, and took various directions, chiefly towards the S. and E., but not always. The mass of them were not brilliant nor rapid, though occasionally there were some splendid specimens of both, and then commonly with a train. Very many of them came apparently from the zenith, faint and blue, and nearly perpendicular. I cannot estimate the number at less than 300; and though it is a mere guess, for I soon found it useless to try and count them, I am inclined to think that below the truth. *Tetney*, (N. lat. 53° 28′; W. lon. 50″) *near Grimsby*, *Lincolnshire*, Dec. 8, 1838."

This account is much less definite than could be desired. The observations appear to have been made chiefly by *one* person, watching only a part of the time.

3. In a letter dated Savannah, Ga., May 4, 1839, Mr. Thomas R. Dutton communicates the following: "After I wrote you in regard to the December shower of 1838, I obtained some information with regard to it from Captain Dyer of the ship Eli Whitney. He was then on his passage from Boston to this place, and off Cape Lookout, (about N. lat. 34°; W. lon. 77°). He made no memoranda at the time, and is not therefore certain of the date, but thinks it was on the night of the *eighth*; [more probably the *seventh*.] He says, 'The meteors started, with few exceptions, from the meridian or near the zenith, and moved to the W. and sometimes S. W. I noticed a few, however, moving to the E. A great many I observed to commence their movement a little to the W. of Capella, and others to the W. of Aldebaran,

and in a few instances from other parts of the heavens. A few left trails of light, but the most of them did not. The greatest number was seen between 8 o'clock and 12, after which comparatively few were observed.' Capt. D. informed me that he must have noticed as many as *two hundred*, during the four hours above mentioned. His testimony is worthy of entire confidence."

None of the observers, whose statements are cited above, were apprised (so far as I can learn) that any thing unusual was expected to occur at the time. On this account, their testimony will perhaps by some be considered more satisfactory. It is to be regretted that the observers did not notice, with more attention, the region of the heavens from which the meteors appeared to radiate.

In regard to the question of the annual occurrence in December of an uncommonly large number of meteors, I annex the following extracts. The evidence which they contain is quite indefinite, and each one may allow them what importance he pleases.

(1.) "The meteors called Falling-stars were much more frequent during this winter than we ever before saw them, and particularly during the month of December," [1824, at Port Bowen, N. lat. 70° 20′; W. lon. 80° 40′]. Then follows a particular account of several meteors observed on the 8th, 9th, 12th, and 14th December. *Compend of the Journals of Capt. Parry's Three Voyages to the Arctic Seas*, (5 vols. 18mo, Lond. 1828,) vol. 5, p. 49, &c.

(2.) M. J. Milbert, in chap. 3, of his *Voyage Pittoresque à l'Ile de France, etc.* (Paris, 1812, 8vo,) gives a sketch of the meteorology of that island, (S. lat. 20°; E. lon. 57° 30′.) In his account of the character of the month of December, he states that this season is the time in which luminous meteors are seen traversing the heavens.* It cannot be determined whether his statement refers to any particular part of the month.

(3.) "During the severe concussions [of the earthquake] of the 4th and 5th, [December, 1809, at the Cape of Good Hope,] the watches and clocks lost a good deal of time, a fire-ball was ob-

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* "Cette saison brûlante est celle aussi ou les météores brillent dans le ciel et se présentent quelquefois comme un énorme globe de feu ou comme une longue fusée qui traverse lentement l'espace, jetant une lumière très vive; d'autres fois ils produisent une détonation aussi forte qu'un coup de canon; il n'est pas rare de voir paraître tout-à-coup dans le ciel ces jets de lumière qui, parfois, se divisent après l'explosion, en laissant une traînée blanchâtre qui forme un léger nuage, et bientôt qui se perd dans l'espace." Tome 2, p. 83.

served over the mountains in the west; various shooting stars appeared; the firmament was completely free of clouds, &c."—*Edinb. Ann. Reg.* for 1809. 8vo, vol. 2, pt. 2, p. 509.

(4.) In an anonymous table of the dates at which unusual numbers of meteors have been seen, contained in the London Monthly Chronicle, (vol. i, No. 9, Nov. 1838,) the *sixth of December*, 1826, is given. What authority there is for it, I do not know. The table seems to be derived chiefly from a similar one published by M. Quetelet, with additions from various papers which have appeared in this Journal.

New Haven, Conn., May 15, 1839.

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ART. XI.—*On the Meteoric Shower of April* 20, 1803, *with an account of observations made on and about the* 20*th April*, 1839; by EDWARD C. HERRICK, Rec. Sec. Conn. Acad.

IT is generally known that in April, 1803, a remarkable shower of shooting stars was witnessed throughout a large part of the United States. In order that an account of this interesting event may be placed on permanent record, I have collected for this Journal the following statements concerning it.

As hypotheses which I do not credit, are often interwoven with the testimony cited, I take occasion here to express my entire dissent from the suppositions that shooting stars, whether single or in showers, are connected, either as cause or effect, with earthquakes, pestilence, electrical discharges, winds, seasons of heat or cold, or any particular sort of weather; or that the movements of these meteors have any correspondence with the direction of the wind, or with lines of magnetic dip or declination. That they are connected with the causes of the Aurora Borealis, is quite doubtful, yet it is well worthy of notice, that very brilliant displays of the latter have often occurred about the 13th of November.

## I. *Meteoric Shower of April* 20, 1803.

1. *General account.*—"The newspapers from North Carolina, Virginia, and New Hampshire, contain accounts of a remarkable exhibition of meteors, or of shooting stars, seen at Raleigh, [N. C.] Richmond, [Va.] and Portsmouth, [N. H.] towards the end of

April, 1803. The beholders have, in several places, given certificates of what they witnessed. They declare that night the heavens seemed to be all on fire, from the abundance of lucid meteors. They passed over head in all directions, and were too numerous to be counted. One witness counted one hundred and sixty-seven in about fifteen minutes, and could not then number them all. This luminous display continued from one until after three o'clock in the morning. Part of the time the light was so great that a pin might be picked up on the ground. The modern opinion of these appearances is, that they consist of phlogistous gas, (inflammable air) catching fire in the upper region of the atmosphere. But it is not easy to explain wherefore the air of so many parts of the continent was so over-charged with hydrogenous vapor so early in the season.[!!] The coruscations are stated from all parts to have been unusually frequent and brilliant."—*Medical Repository*, (8vo, New York,) 2d Hex. vol. i, 1803–4, p. 300.

2. *Observations at Richmond*, Va., N. lat. 37° 32′; W. lon. 77° 26′. "*Shooting Stars.*—This electrical phenomenon was observed on Wednesday morning last at Richmond and its vicinity, in a manner that alarmed many, and astonished every person who beheld it. From one until three in the morning, those starry meteors seemed to fall from every point in the heavens, in such numbers as to resemble a shower of sky rockets. The inhabitants happened at the same hour to be called from their houses by the fire-bell, which was rung on account of a fire that broke out in one of the rooms of the Armoury, but which was speedily extinguished. Every one, therefore, had an opportunity of witnessing a scene of nature, which never before was displayed in this part of the globe, and which probably will never appear again. Several of these shooting meteors were accompanied with a train of fire, that illuminated the sky for a considerable distance. One, in particular, appeared to fall from the zenith, of the apparent size of a ball of eighteen inches diameter, that lighted for several seconds the whole hemisphere. During the continuance of this remarkable phenomenon, a hissing noise in the air was plainly heard, and several reports, resembling the discharge of a pistol. Had the city bell not been ringing, these reports would probably have seemed louder. The sky was remarkably clear and serene, and the visible fixed stars numerous the whole night. We are anxious to know at what distance from Richmond this phenome-

non has extended. It is hoped that persons who have remarked it in other places, will not neglect to inform the public of the particulars; as such information may add in a great degree to the knowledge of meteorology.

"Since writing the above, we have been informed that several of the largest of these shooting meteors, were observed to descend almost to the ground before they exploded. Indeed, many of those which we saw, appeared to approach within a few yards of the house tops, and then suddenly to vanish. Some persons, we are told, were so alarmed, that they imagined the fire in the Armoury was occasioned by one of these meteors, and in place of repairing to extinguish the earthly flames, they busied themselves in contriving to protect the roofs of their houses from the fire of heaven.

"This circumstance of the shooting stars descending within a short distance of the ground, is, however, a fact highly important to be known; as it has been generally supposed that meteors only proceed in a horizontal direction and never fly perpendicularly upwards or downwards. Those which we particularly remarked, appeared to descend in an angle of sixty degrees with the horizon; but as the smaller ones were so numerous and crossed each other in different directions, it was only possible to ascertain with any precision, the paths of the largest and most brilliant." —*Quoted in N. Y. Spectator, of April* 30, 1803, *from the Virginia Gazette, of Richmond, April* 23, 1803.

3. *Observations in Schoharie Co., N. Y.* N. lat. 42½°; W. lon. 74½°.—"In the Balance of the 17th ult. we republished from the Virginia Gazette, an account of a remarkable phenomenon which was observed in Richmond. The same appearance of innumerable meteors or shooting stars, has also been announced from various parts of Massachusetts; and we have just received a communication from a gentleman of veracity and respectability, who resides in Schoharie Co. in this State, which gives in substance the following particulars. He was returning home from a journey, late in the same night that the meteors were observed at Richmond, when he was astonished at the immense number of shooting stars which fell in all directions around him. Some of them approached so near the earth, that he could plainly distinguish them between the high hills on the east and west sides of him, which were distant not more than half a mile. Those that

seemed to fall nearest were apparently as large as a barrel [!] and had tails from 12 to 20 feet in length. He judges there was no intermission (as to numbers and motion) for two hours, during which time the whole hemisphere was illuminated."—*The Balance*, (Hudson, N. Y.) vol. 2, p. 205, June 28, 1803.

4. *Observations at Wilmington, Del.* N. lat. 39° 41′; W. lon. 75° 28′.—"On the 16th and 17th [April, 1803] we had a brisk storm with torrents of rain and lightning; and early in the morning of the 20th, electrical meteors were surprisingly numerous and vivid. Newspaper accounts since inform us that the same phenomena were observed over a great part of the country."—Dr. John Vaughan, in N. Y. Med. Repos. 2d hex. vol. 2, (1805) p. 140.

These are all the accounts of the display which I have been able to procure. They give no information concerning the point of radiation, or the hour of the greatest abundance. The radiant point was doubtless north of the ecliptic; and it is perhaps not unreasonable to conjecture that it was (as seen in this latitude) near the region of the heavens where it appeared to be on the morning of the 19th of April, 1839.*

This meteoric shower appears to be the legitimate successor of those which occurred April 4th,† (morning of 5th,) A.D. 1095, and April 5th, (morning) A. D. 1122, (both of the Julian style, corresponding nearly to the 11th of the Gregorian.) I have not succeeded in finding any meteoric shower in April, between 1122 and 1803, and can not determine whether there has been a regular progression in the time of the recurrence of the phenomenon. No evidence has come to my knowledge, that any such display was seen in April, 1830.

II. *Observations on shooting stars, on and about April* 20, 1839.

1. *New Haven.*—On the morning of Friday the 19th, Mr. Francis Bradley and myself watched from midnight until 3

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* The idea advanced by M. Valz, (Com. Ren. Acad. Sci. 1838, 2d sem. p. 977,) that during meteoric displays of the same name, in any two successive years, the meteors appear to move in contrary directions, is irreconcilable with various observations which have been made in this country; and it is quite improbable, viewed theoretically. A short time will determine the question.

† Erroneously stated April 25, 1095, in Com. Ren. 1836, 2d sem. p. 145, from which work this date has been often quoted.

o'clock. The sky was clear, and the moon interfered only until about 1 A. M. One watched in the North quarter, the other in the South. During the three hours, we observed fifty eight meteors as follows:

From 0h. to 1h. A. M. in N. nine; in S. nine = 18
1 " 2 " " " eleven; " six = 17
2 " 3 " " " thirteen; " ten = 23

Several of the meteors were large, and left trains, but there was nothing remarkable in this respect. One apparently as large as Jupiter, fell near the horizon in the N. W. about a quarter past two o'clock, which as it burst, shot forth three red fire-balls. The times of flight were generally less than half a second. Soon after we took our stations, we noticed that the apparent paths of the majority of the meteors, if traced back, would meet in a spot somewhere between $\alpha$ *Lyræ* and $\gamma$ *Draconis*, (about R. A. 273°, N. D. 45°,) and the radiant did not appear to change its place among the stars as they moved westward.

On the morning of the 20th, Messrs. C. P. Bush, M. Canales, J. T. Seeley and myself, began observations at fifteen minutes past midnight. During the hour next following, we observed *nineteen* meteors. The radiant could not be so well determined as on the morning previous. The time was unfavorable:—the moon (then near the first quarter) interfered, and the sky was partially clouded. In good circumstances, we should probably have seen double the number. Considering this quantity as only about equal to the yearly average, we concluded to abandon the field. An accident entirely prevented any further observation on my part, for several days succeeding.

2. *Hudson*, O.—The observations of four members of Western Reserve College were obtained, through the kindness of Prof. Loomis. On the 19th, from 2 h. to 3 h. A. M., two observers, looking from E. to W. by way of S., saw *thirteen* meteors; from 3 h. to 4 h., *twelve*. On the 20th, two observers, saw, from 2 h. to 3h. A. M., *twelve*; from 3 h. to 4 h. *thirteen*.

3. *Geneva*, N. Y.—Mr. Azariah Smith, Jr. watched at various times on the mornings of the 16th, 19th, and 20th. He saw several meteors, (two of unusual splendor on the 19th,) but the number was not above the average. All, or nearly all of them, came from the head of Draco.—Observations at *Rochester, N. Y.* and at *Claiborne, Ala.* detected nothing unusual. The news-

papers mention that at *Charleston*, S. C., at 10 o'clock, P. M. of the 20th, a fire-ball of great splendor was seen in the North.

The details above given lead to the conclusion, that no unusual display of meteors was visible in this country on the mornings of the 19th or 20th April, 1839. It is to be regretted that no thorough observation was made on the mornings of the 21st and 22d.

It deserves to be mentioned, that the meteoric shower of April, 1803, is by European writers, almost universally referred to the *twenty-second* day of the month. The documents which I have quoted, compel the belief that the true date is the *twentieth.* The only ground for suspicion concerning it, is the apparent failure on this day, for two successive years, of any recurrence of the shower.

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ART. XII.—*Notice of a Report on a re-examination of the Economical Geology of Massachusetts;* by EDWARD HITCHCOCK, Professor of Chemistry and Natural History in Amherst College. Boston, 1838.

Communicated by Professor C. U. SHEPARD, at the request of the Editors.

THE objects aimed at in the undertaking, were 1st, the collection and analysis of soils, with a view to their amelioration on chemical principles; 2nd, the discovery of coal, marl and ores; 3rd, a more accurate determination of the boundaries to the various rock formations; 4th the scientific geology, and lastly to procure additional specimens for the illustration of the geology and mineralogy of the State.

Prof. HITCHCOCK confines himself however, in the present report pretty nearly to the first and second topics above enumerated, and dwells particularly upon those developements of valuable materials within the commonwealth, which have been effected since the publication of his earlier reports.

As a preliminary to the consideration of soils, he classifies the different kinds observed as follows:

1. Alluvium from rivers, do. peaty; 2. Tertiary soil, do. sandy; 3. sandstone soil, red, do. gray; 4. Graywacke soil, conglomerate, do. slaty gray, do. slaty red; 5. Clay slate soil; 6. Limestone soil, magnesian, do. common; 7. Mica slate soil; 8.

Talcose slate soil; 9. Gneiss soil, common, do. ferruginous; 10. Granite soil; 11. Sienite soil; 12. Porphyry soil; 13. Greenstone soil.

The principal deposites of the 2d variety of soil occur in the valley of the Connecticut river, and in the counties of Plymouth, Barnstable, Dukes and Nantucket. "The surface on these places is usually covered with a white or yellowish silicious sand, which forms one variety of these soils. Where the sand is washed away, a deposite of clay is exposed, white, or whitish in the southeastern part of the state, but bluish on Connecticut river. This is the other variety of tertiary soils. Either of them in a pure state, is exceedingly barren; but duly mixed, they form a very productive soil." (p. 10.)

The limestone soil is confined to the county of Berkshire. It is thus denominated because it contains more of the salts of lime than any of the other soils of the state, although the calcareous earth even in the limestone soil, is by no means abundant, it having, in the opinion of Prof. H., been partially withdrawn by cultivation.

The specimens of soil for analysis were taken in nearly every instance from cultivated ploughed fields, and when practicable, from land which had been long enough under cultivation to cause the decay of all coarse vegetable fibres. Care was observed to avoid on the one hand, rich soil situated near to houses, and on the other, worn out and neglected fields. The samples were obtained at a depth of three or four inches below the surface; and in the selection, roots, undecayed manure, and large pebbles were rejected. After having been previously spread for several days upon boards, during the dry days of October, they were transferred to tin canisters. A portion of each specimen was withdrawn for analysis, and the remainder was enclosed in a glass bottle, which is intended for preservation in the State collection. One hundred and twenty such bottles were collected, besides fifty others, containing marls, clays, muck-sand, marsh-mud, ochres, &c.

In proceeding to the analysis of these numerous specimens, Prof. H. remarks, that the objects were, 'first, to ascertain the nature and amount of the earths that form the basis of the soils. Secondly, the nature and amount of the salts that act as stimulants to vegetation; and thirdly, to determine the amount and

condition of the organic matter which constitutes the nourishment of plants.'

The time at his command, however, was inadequate to a rigid analysis of these soils, according to the rules laid down for the nicest processes of quantitative research. Being forced to conduct many analyses contemporaneously, the use of silver and platinum vessels was of necessity out of the question; nor was there room to verify results by repetition; still he believes that a sufficient approximation to the truth was secured, to answer the purposes intended.

The almost total absence of carbonate of lime is a remarkable feature in the soils of Massachusetts. But seven specimens of the whole number effervesced with hydrochloric acid, when examined with the utmost care to observe this phenomenon; nor did either of these examples afford carbonate of lime in a higher ratio than about 3 per cent.

It was a leading object in the research to determine the quantity of finely divided matter in the soil, since the best soils are usually characterized by their fineness. Prof. H. thinks the main defect of their soils to consist in the coarseness of their texture, and this he very properly attributes to the circumstance of their originating, for the most part, directly from primary rocks.

The salts soluble in water, equalled from 1 to 2 parts in a thousand of the soil, and in every case it was believed to contain sulphate of lime (gypsum.) Carbonate of magnesia was also very frequently an ingredient, though in mere traces. The presence of soda and potassa was not determined. The peroxide of iron exists from 1 to 4 per cent., and upwards in few instances. Prof. H. regards this last as an useful ingredient in soils. The ratio of the alumina to the other ingredients varies from 1 to 18 per cent. The instances are common in which he found it above 10 per cent., which is beyond what might have been supposed for a region where the argillaceous formations are so uncommon as they are in Massachusetts.

In respect to the earthy ingredients of a soil, it is undoubtedly true that a very wide diversity of constitution is compatible with fertility, provided the mechanical condition, and the proportions of salts and organic matter are propitious. Prof. H. is of opinion that 'the salts especially admit of but little variation without producing sterility, either by their deficiency or excess; and

hence to determine their amount is an important point in agricultural chemistry. And the differences which are so obvious in soils derived from different rocks, do not depend entirely upon the different proportions of the earths which they contain. For the quantity and nature of the salts resulting from the decomposition of rocks are considerably different. Thus we should expect, that the gneiss and granite soils would contain a larger amount than usual of the salts of potassa, and where sulphuret of iron prevails, of the salts of iron; the porphyry soils, of the salts of soda; the graywacke and sandstone soils, of the salts of lime, magnesia, and perhaps potassa and soda; the mica slate soils, of the salts of magnesia and potassa; the talcose slate soil, of the salts of magnesia: or perhaps more commonly we should find the lime and magnesia *uncombined* with an acid,' (we do not perceive how this can be.)

'Such differences as these in the constituents of soil, will unquestionably affect their fertility; and it would be desirable to ascertain how far they exist in the soils of Massachusetts. I had hoped to accomplish this object; but it will require a great number of delicate and accurate analyses, demanding far more time than has yet been allowed me. As will be seen in the sequel, I have attempted to determine the amount of the salts of lime in all the soils that I have collected; but it will need comparative trials by the ordinary modes of analysis before the peculiar characteristics of the different classes of our soil can be pointed out; and besides I have made no attempt to determine the existence and amount of potassa and soda in my specimens.' p. 27.

Prof. H. next proceeds to the developement of a new method of analysis derived from Dr. Samuel L. Dana of Lowell, Mass., and which Prof. H. regards as a most important contribution to agricultural chemistry. The account is prefaced by the following remarks from Dr. D.

"Geine forms the basis of all the nourishing part of all vegetable manures. The relations of soils to heat and moisture depend chiefly on geine. It is in fact, under its three states of 'vegetable extract, geine, and carbonaceous mould,' the principle which gives fertility to soils long after the action of common manures has ceased. In these three states it is essentially the same. The experiments of Saussure have long ago proved that air and moisture convert insoluble into soluble geine. Of all the problems to be solved by agricultural chemistry, none is of so great practical importance as the determination of the quantity of soluble and insoluble geine in soils. This is a question of much higher importance than the nature and proportions of the earthy constituents and soluble salts of soils. It lies at the foundation

of all successful cultivation. Its importance has been not so much overlooked as undervalued. Hence, on this point the least light has been reflected from the labors of Davy and Chaptal. It needs but a glance at any analysis of soils, published in the books, to see that fertility depends not on the proportion of the earthy ingredients. Among the few facts, best established in chemical agriculture, are these; that a soil, whose earthy part is composed wholly, or chiefly, of one earth; or any soil, with excess of salts, is always barren; and that plants grow equally well in all soils, destitute of *geine*, up to the period of fructification,—failing of geine, the fruit fails, the plants die. Earths, and salts, and geine, constitute, then, all that is essential; and soils will be fertile, in proportion as the last is mixed with the first. The earths are the plates, the salts the seasoning, the geine the food of plants. The salts can be varied but very little in their proportions, without injury. The earths admit of wide variety in their nature and proportions. I would resolve all into '*granitic sand*;' by which I mean the finely divided, almost impalpable mixture of the detritus of granite, gneiss, mica slate, sienite, and argillite; the last, giving by analysis, a compound very similar to the former. When we look at the analysis of vegetables, we find these inorganic principles constant constituents—silica, lime, magnesia, oxide of iron, potash, soda, and sulphuric and phosphoric acids. Hence these will be found constituents of all soils. The phosphates have been overlooked from the known difficulty of detecting phosphoric acid. Phosphate of lime is so easily soluble when combined with mucilage or gelatine, that it is among the first principles of soils exhausted. Doubtless the good effects, the lasting effects, of bone manure, depend more on the phosphate of lime, than on its animal portion. Though the same plants growing in different soils are found to yield variable quantities of the *salts* and earthy compounds; yet I believe, that accurate analysis will show, that similar parts of the same species, at the same age, always contain the inorganic principles above named, when grown in soils arising from the natural decomposition of granite rocks. These inorganic substances will be found not only in constant quantity, but always in definite proportion to the vegetable portion of each plant. The effect of cultivation may depend, therefore, much more on the introduction of *salts* than has been generally supposed. The *salts* introduce new breeds. So long as the salts and earths exist in the soil, so long will they form voltaic batteries with the roots of growing plants; by which, the 'granitic sand' is decomposed, and the nascent earths, in this state readily soluble, are taken up by the absorbents of the roots, always a living, never a mechanical operation. Hence so long as the soil is *granitic*, using the term as above defined, so long is it as good as on the day of its deposition; *salts* and *geine* may vary, and must be modified by cultivation. The universal diffusion of granitic diluvium will always afford enough of the earthy ingredients. The fertile character of soils, I presume, will not be found dependent on any particular rock formation on which it reposes. Modified they may be, to a certain extent, by peculiar formations; but all our granitic rocks afford, when decomposed, all those inorganic principles which plants demand. This is so true, that on this point the farmer already knows all that chemistry can teach him. Clay and sand, every one knows: a soil too sandy, too clayey, may be modified by mixture, but the best possible mixture does not give fertility. That depends on salts and geine. If these views are correct, the few properties of geine which I have mentioned, will lead us at once to a simple and accurate mode of analysing soils,—a mode, which determines at once the value of a soil, from its quantity of soluble and insoluble vegetable nutriment,—a mode, requiring no array of apparatus, nor delicate experimental tact,—one, which the country gentleman may apply with very great accuracy; and, with a little modification, perfectly within the reach of any man who can drive a team or hold a plough."

*Rules of Analysis.*

1. "Sift the soil through a fine sieve. Take the fine part; *bake* it just up to browning paper."

2. "Boil 100 grains of the baked soil, with 50 grains of pearl ashes, saleratus or carbonate of soda, in 4 ounces of water, for half an hour; let it settle; decant the clear; wash the grounds with 4 ounces boiling water; throw all on a weighed filter, previously dried at the same temperature as was the soil, (1); wash till colorless water returns Mix all these liquors. It is a brown colored solution of all the soluble geine. All sulphates have been converted into carbonates, and with any phosphates, are on the filter. Dry therefore, that, with its contents, at the same heat as before. Weigh—the loss is *soluble geine.*"

3. "If you wish to examine the geine; precipitate the alkaline solution with excess of lime-water. The *geate* of lime will rapidly subside, and if lime-water enough has been added, the nitrous liquor will be colorless. Collect the geate of lime on a filter; wash with a little acetic or very dilute muriatic acid, and you have geine quite pure. Dry and weigh."

4. "Replace on a funnel the filter (2) and its earthy contents; wash with 2 drams muriatic acid, diluted with three times its bulk of cold water. Wash till tasteless. The carbonate and phosphate of lime will be dissolved with a little iron, which has resulted from the decomposition of any salts of iron, besides a little oxide of iron. The alumina will be scarcely touched. We may estimate all as *salts* of lime Evaporate the muriatic solution to dryness, weigh and dissolve in boiling water. The insoluble will be *phosphate of lime.* Weigh—the loss is the *sulphate of lime*; (I make no allowance here for the difference in atomic weights of the acids, as the result is of no consequence in this analysis.)"

5. "The earthy residuum, if of a greyish white color, contains no insoluble geine—test it by burning a weighed small quantity on a hot shovel—if the odor of burning peat is given off, the presence of insoluble geine is indicated. If so, *calcine* the earthy residuum and its filter—the loss of weight will give the insoluble geine; that part which air and moisture, time and lime, will convert into soluble vegetable food. Any error here will be due to the loss of water in a hydrate, if one be present, but these exist in too small quantities in 'granitic sand,' to affect the result. The actual weight of the residuary mass is 'granitic sand.'

"The clay, mica, quartz, &c. are easily distinguished. If your soil is calcareous, which may be easily tested by acids; then before proceeding to this analysis, boil 100 grains in a pint of water, filter and dry as before, the loss of weight is due to the *sulphate of lime*, even the sulphate of iron may be so considered; for the ultimate result in cultivation is to convert this into sulphate of lime."

"Test the soil with muriatic acid, and having thus removed the lime, proceed as before, to determine the geine and insoluble vegetable matter."* pp. 32–35.

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* In applying Dr. Dana's rules given in the text, to the soils of Massachusetts, I found it necessary to adopt some method of carrying forward several processes together. I accordingly made ten compartments upon a table, each provided with apparatus for filtering and precipitations, also 10 numbered flasks, 10 evaporating dishes, and a piece of sheet iron pierced with ten holes, for receiving the same number of crucibles. I provided, also, a sheet iron oven, with a tin bottom large enough to admit 10 filters, arranged in proper order, and a hole in the top to admit a thermometer. The sand bath was also made large enough for receiving the ten flasks. In this manner I was able to conduct ten processes with almost as great facility as one could have been carried forward in the usual way.

A tabular view is given in the report of 125 analyses of soils, conducted on the principles above laid down. The first column of the table gives the soluble geine, the 2d, the insoluble geine, the 3d, sulphate of lime, the 4th, the carbonate of lime, the 5th, the phosphate of lime, the 6th, the granitic sand, the 7th, the moisture absorbed in 24 hours by 100 grs. of the soil previously heated up to 300° F., the 8th, the absorbing power in proportional numbers, and the last, the specific gravity of the soil.

Notwithstanding the expedition with which examinations according to the foregoing rules are capable of being made, we cannot but express our astonishment at the zeal and patience with which the author must have labored in order to bring forward so many results. And whatever may be the value which the chemical reader may attach to the formula by which they are conducted, taken as a whole, still, in regard to the columns of organic matter, of absorbing power and specific gravity, no objections are likely to be urged.

Of Dr. DANA's hypothesis respecting the state in which vegetable and animal matter exists in the soil, and the changes through which it passes before being taken up by the roots of the plants, it is exceedingly doubtful whether the progress of organic chemistry will ever raise it to the character of chemical theory. Recent researches would rather lead us to regard soluble geine as composed of at least three vegetable acids, viz. the crenic, apocrenic, and ulmic, together with a black matter called by HERMANN (Journ. d' ERDM. t. 12, p. 277,) *earthy extract:* while the insoluble geine is ulmic acid mingled with undecomposed vegetable remains. HERMANN gives the following view of the constitution of the above acids.

| | Crenic. | | Apocrenic. | | Ulmic. |
|---|---|---|---|---|---|
| Carbon, | 535. | (= 7 atoms.) | 1070.1 | (= 14 atoms.) | 6190. |
| Hydrogen, | 99.8 | (= 16 " ) | 87.3 | (= 14 " ) | 431. |
| Nitrogen, | 88.5 | (= 1 " ) | 265.5 | (= 3 " ) | 1105. |
| Oxygen, | 600. | (= 6 " ) | 500. | (= 3 " ) | 2274. |
| | 1323.3 | (combining weight.) | 1722.9 | (combining wt.) | 10000. |

What therefore Dr. D. considers a simple salt, (a geate,) is more probably a family of salts, viz. a crenate, an apocrenate, and an ulmate, with the addition moreover of earthy extract. How these principles become the nutriment of plants is yet far from being

cleared up, although there remains the best reason for supposing that it chiefly depends upon their capacity to afford carbonic acid. The more alkaline the bases united with these acids in a particular soil, the more favorable are the conditions for vegetation, a fact which is apparently connected with the superior solubility of alkalescent salts.

It may be doubted whether the steps directed to be taken in the analysis for the determination of the salts of lime are free from all objection. The treatment of the soil after being freed from geine, with dilute hydrochloric acid, must necessarily take into solution aluminium and iron, beside rendering a portion of the silicic acid soluble. On evaporating the fluid to dryness as directed, and treating the mass with boiling water, it would therefore follow that a residuum of alumina and sesquioxide of iron, (owing to the partial decomposition of the chlorides of aluminium and iron from evaporation to dryness,) together with some silicic acid (rendered insoluble by the same treatment,) would go to increase the weight assumed to be pure phosphate of lime.

As might be anticipated therefore, we find the ratio of phosphate of lime in the soils of Massachusetts exceedingly high, varying from 0.5 to 2 per cent.

Growing out of the same procedure, it appears also, that the proportion of sulphate of lime must generally be rather too high: for if, as we suppose, the hydrochloric acid attacks the aluminium and iron, the aqueous solution regarded in the formula as chlor. calcium only, must contain also the chlorides of iron and aluminium, as well as some silicic acid. Consequently, we find the sulphate of lime quoted in some of these analyses at 3 p. c., and even higher in a few instances.

The foregoing inadvertencies (as they strike us) in Dr. Dana's rules of analysis, are not conceived to vitiate in an important manner the results contained in the report, nor do we mention them because we imagine they were unperceived by the inventor of the formula or by Prof. H.; but through a desire to induce these gentlemen to obviate, if possible, the objections urged against it, and still preserve its claims to convenience on the ground of facility of working and accuracy of result.

The report contains the following remarks respecting the results of these analytic investigations.

They show us the amount of nutriment in the soils of Massachusetts; also how much of it is in a fit state to be absorbed by plants, and how much of it will need further preparation. As this is probably the first attempt that has been made to obtain the amount of geine in any considerable number of soils, we cannot compare the results with those obtained in other places. They will be convenient, however, for comparison with future analyses; and we learn from them, that geine, in both its forms, abounds in the soils of the state, and that it most abounds where most attention has been paid to cultivation. It ought to be recollected, that I took care not to select the richest or the poorest portions of our soils; so that the geine in this table is probably about the average quantity. It is hardly probable that the number of specimens analysed from the different varieties of our soils is sufficiently large to enable us to form a very decided opinion as to their comparative fertility, especially when we recollect how much more thorough is the cultivation in some parts of the state than in others. It may be well, however, to state the average quantity of geine in the different geological varieties of our soils, which is as follows:

| | Soluble Geine. | Insoluble Geine. |
|---|---|---|
| Alluvium, | 2.25 | 2.15 |
| Tertiary argillaceous soils, | 3.94 | 5.22 |
| Sandstone do. | 3.28 | 2.14 |
| Graywacke do. | 3.60 | 4.00 |
| Argillaceous slate do. | 5.77 | 4.53 |
| Limestone do. | 3.40 | 4.04 |
| Mica slate do. | 4.34 | 4.60 |
| Talcose slate do. | 3.67 | 4.60 |
| Gneiss do. | 4.30 | 3.40 |
| Granite do. | 4.05 | 3.87 |
| Sienite do. | 4.40 | 4.50 |
| Porphyry do. | 5.97 | 4.10 |
| Greenstone do. | 4.56 | 6.10 |

One fact observable in the above results may throw doubts over the fundamental principles that have been advanced respecting geine; viz. that it constitutes the food of plants, and that they cannot flourish without it. It appears that our best alluvial soils contain less geine, in both its forms, than any other variety, except those very sandy ones that are not noticed in the above results, because their number is so small. Ought we hence to infer that alluvium is a poor soil? I apprehend that we can infer nothing from this fact against alluvial soils, except that they are sooner exhausted than others, without constant supplies of geine. For if a soil contain enough of this substance abundantly to supply a crop that is growing upon it, that crop may be large although there is not enough geine to produce another. Now analysis shows that our alluvial soils contain enough of geine for any one crop: and I apprehend that their chief excellence consists in being of such a degree of fineness that they allow air, moisture, and lime, rapidly to convert vegetable matter into soluble geine, and yield it up readily to the roots of plants: but I presume that without fresh supplies of manure, they would not continue to produce as long as most of the other soils in the state. A considerable part of our alluvia are yearly recruited by a fresh deposite of mud, which almost always contains a quantity of geine and of the salts of lime, in a fine condition for being absorbed by the rootlets of plants. And on other parts of alluvial tracts, our farmers, I believe, are in the habit of expecting but a poor crop unless they manure it yearly. Yet so finely constituted are these soils, that even if exhausted, they are more easily restored than most others; so that taking all things into the account, they are

among the most valuable of our soils; and yet I doubt whether they produce as much at one crop as many other soils; though the others perhaps require more labor in cultivation.

The amount of soluble and insoluble geine obtained by Dr. Dana's method of analysis, ought to correspond pretty nearly with the amount of organic matter obtained by the old method; and by comparing the two tables of results that have been given, it will be seen that such is the fact. Several circumstances, however, besides errors of analysis, will prevent a perfect agreement. In the first place, by the old method of analysis, 100 grains of the soil are weighed before expelling the water of absorption; but by the new method, not until after its expulsion. Again, by the old method only the very coarse parts of the soil are separated by the sieve: but a fine sieve is used by the new mode, and this removes nearly all the vegetable fibre, which by the other method is reckoned a part of the organic matter. Other causes of difference might be named: and hence we ought not to expect a perfect agreement in the results of the two methods.

The three next columns in the Table contain the salts of lime in our soils. I have already described the infrequency of the carbonate; but very different is the case with the sulphate and the phosphate which were found in greater or less quantity, in every soil analysed. In respect to the sulphate of lime, or gypsum, it may not be unexpected that we should find it in all soils, since we know it to occur in all natural waters throughout the state; and we cannot conceive of any other source from which the water could have derived it, except the soil. But the phosphate of lime has generally been supposed to be much more limited, nay to be scarcely found in soils, except where animal substances have been used for manure. It is possible that in all the soils which I have analysed, such might have been its origin, though not very probable. Yet there is strong reason to believe, that this salt is a constituent of all soils in their natural state. The arguments on this subject are stated so ably by Dr. Dana that I need only quote from his letter.

"When we consider that the bones of all graminivorous animals contain nearly 50 per cent. of phosphate of lime, we might be at liberty to infer the existence of this principle, in the food, and, consequently, in the soil, on which these animals graze. If we look at the actual result of the analysis of beets, carrots, beans, peas, potatoes, asparagus, and cabbage, we find phosphate of lime, magnesia, and potash, varying from 0.04 to 1.00 per cent. of the vegetable. Indian corn too, by the analysis of the late Professor Gorham, of Harvard College, contains 1.5 per cent. phosphate and sulphate of lime. It may be said that this is all derived from the manure. We shall see by and by. Let us look at the extensive crops often raised where man has never manured. Rice, wheat, barley, rye, and oats, all contain notable portions of phosphate of lime, not only in the grain but in the straw, and often in the state of superphosphates. The *diseases* too, *ergot* and *smut*, show *free phosphoric acid*. Can it be that, owing to certain electrical influences of the air, in particular seasons, lime is not secreted by the plant to neutralize the free acid? May not this be a cause of smut and ergot? Does it not point out a remedy? Take too the cotton crop of our country. What vast quantities of phosphates do we thus annually draw from the soil? Cotton gives one per cent. ashes, of which 17 per cent. is composed of phosphate of lime and magnesia. The like is true of tobacco. It contains 0.16 per cent. of phosphate of lime. If we turn to the analysis of forest trees, we find that the *pollen* of the *pinus abies*, wafted about in clouds, is composed of 3 per cent. phosphate of lime and potash. May not this too be one of nature's beautiful modes of supplying phosphoric acid to plants and to soils? If, as the late experiments of Peschier have proved, sulphate of lime, in powder, is decomposed be growing leaves, the lime liberated, and the sulphuric acid combining with the

potash in the plant, why may not phosphate of lime, applied by *pollen*, act in the same way? At any rate, the existence of phosphate of lime in our forest soils is proved not only by its existence in the pollen, but by its actual detection in the ashes of pines and other trees.—100 parts of the ashes of *wood* of *pinus abies* give 3 per cent. phos. iron; 100 parts of the ashes of the *coal* of *pinus sylvestris* give 1.72 phos. lime, 0.25 phos. iron; 100 parts of ashes of oak coal, give 7.1 phos. lime, 3.7 phos. iron; 100 parts of ashes of bass wood 5.4 phos. lime, 3.2 phos. iron; 100 parts of ashes of birch wood 7.3 phos. lime, 1.25 phos. iron; 100 parts of ashes of oak wood 1.8 phos. lime; 100 parts of ashes of alder coal 3.45 phos. lime, 9. phos. iron.

"These are the calculated results from Berthier's very accurate analyses, and those very curious crystals—detected in some plants—the '*raphides*' of DeCandolle, are some of them bibasic phosphates of lime and magnesia. Phosphate of iron, we know, is common in turf; bog ore, and some barren and acid soils owe their acidity to *free* phosphoric acid. If we allow that our untouched forest soil contains phosphate of lime, it may be said, that this, being in small quantity, will be soon exhausted by cultivation, and that the phosphates, which we now find in cultivated fields, rescued from the forest, is due to our manure;—I give you the general result of my analysis of *cow dung*, as the best argument in reply. My situation and duties have led me to this analysis. I give you it, in such terms as the farmer may comprehend: water, 83.60; hay, 14.; biliary matter, (bile resin, bile fat and green resin of hay,) 1.275; geine combined with potash, (vegetable extract,) 0.95; albumen, 0.175."

"The hay is little more altered than by chewing. The albumen has disappeared, but its green resin, wax, sulphate and phosphate of lime remain, and when we take 100 parts of dung, among its earthy salts we get about 0.23 parts phosphate, 0.12 carbonate, and 0.12 sulphate of lime. Now, a bushel of green dung as evacuated weighs about 87.5 lbs. Of this only 2.40 per cent. are soluble. Of this portion only 0.95 can be considered as soluble geine."—pp. 43–47.

For the sake of comparison, Prof. H. has subjected a few specimens of soil taken from fertile western lands to the same kind of analysis.

| | Soluble Geine. | Insoluble Geine. | Sulphate of Lime. | Phosphate of Lime. | Carbonate of Lime. | Granitic Sand. | Water of Absorption. | Remarks. |
|---|---|---|---|---|---|---|---|---|
| Rushville, Illinois, | 7.4 | 2.5 | 3.4 | 0.6 | 1.5 | 84.6 | 6.3 | |
| Sangamon co. do. | 4.9 | 5.6 | 1.2 | 0.4 | 1.3 | 86.6 | 6.3 | |
| Lazelle county, do. | 7.6 | 13.8 | 1.4 | 0.4 | 3.3 | 73.5 | 9.5 | Apparently never cultivated. |
| Peoria county, do. | 3.1 | 4.8 | 3.5 | 1.0 | | 87.6 | 5.7 | |
| Sciota Valley, Ohio, | 4.5 | 6.7 | 2.1 | 0.9 | 2.8 | 83.0 | 5.3 | Cultivated 14 years without manure. |

The above soils are evidently of the very first quality: the geine being in large proportion, and the salts quite abundant enough, while there is still a small supply of carbonate of lime to convert more insoluble into soluble geine, whenever occasion demands. Still, if we compare the preceding analyses with some of those that have been given of the Massachusetts soils, the superiority of the western soils will not appear as great as is generally supposed. And there is one consideration resulting from the facts that have been stated respecting geine, that ought to be well

considered by those who are anxious to leave the soil of New England that they may find a more fertile spot in the West. Such soils they can undoubtedly find; *for geine has been for ages accumulating from the decomposition of vegetation in* regions which have not been cultivated: and for many years, perhaps, those regions will produce spontaneously. But almost as certain as any future event can be, continued cultivation will exhaust the geine and the salts, and other generations must resort to the same means for keeping their lands in a fertile condition as are now employed in Massachusetts, viz. to provide for the yearly supply of more geine and more salts.—pp. 47,48.

Next follows some remarks upon the power of soils to absorb water. This is conceived to depend principally upon the organic matter they contain, and next upon the proportion of alumina, after which cabonate of lime is considered favorable to the imbibition of moisture. These ingredients of soil being essential to fertility, the absorbing power, if correctly ascertained, becomes to some extent a measure of its productiveness. Prof. HITCHCOCK's method of determining the problem in question, was to expose 100 grs. previously heated to 300° F. in a cellar for 24 hrs. on a small earthern plate. At the end of this period, the plate was again weighed and the increase ascertained.

The power of a soil to absorb moisture is no doubt a very important consideration to the agriculturalist; and it appears to us to depend upon several conditions beside those above hinted at. For example, the mechanical condition of the soil must materially influence its capacity for acquiring moisture. A finely comminuted soil will absorb in a higher ratio than one which is coarse or gravelly. The presence of carbonate of potassa, or chloride of calcium, by their deliquescent properties will also powerfully augment the absorbability of a soil. It is in part owing to the alkaline carbonate referred to, that the light soils in and near New Milford, (Conn.) possess such superior qualities for agriculture. This carbonate is supplied without interruption from the decomposing state of the feldspar in the granitic gneiss hills (called Candle Mt. range) situated west of the village, and which run northward to Cornwall. We know also, that wood-ashes constitute the best amendment for light silicious soils, rendering them productive in almost every species of crop, even when applied with very small quantities of other manure. Illustrations of this fact are frequent upon Long Island and the dry sand soils of the Connecticut valley.

A new method for learning the absorbing qualities of soils has lately been practiced by M. BERTHIER,* which appears to us as particularly deserving of notice. It consists in filling a small filter with the dry soil, and then thoroughly moistening it until water drops from it; when the water has ceased dropping, the filter with its contents is transferred to one cup of a balance and a moistened filter of the same size to the other, when the gain in weight is noted. The following are some results obtained in this way by BERTHIER:

A vegetable soil from Ormeson, near Nemours, of a pale ochre yellow color, taken from a vineyard and considered of excellent quality, absorbed 0.36 its weight of water.

Quartzy sand of Nemours, such as is employed in the glass factory of Bagneaux, absorbed 0.227.

Quartzy sand of Aumont pulverized in a mortar, absorbed 0.30.

The kaolin of Limoges, absorbed 0.46.

The chalk of Meudon, when purified and in the condition of Spanish white, gained by the process 0.35 its weight.

The report contains likewise several interesting experiments directed to the converse of this problem, viz. to ascertain the capacity of soils to retain water, which is by no means proportional to their powers of absorption: for these results we must refer the reader to the report.

Prof. Hitchcock comes at the following very just conclusions in respect to the soils of Massachusetts, viz. that the grand desiderata in them are carbonate of lime and an additional supply of geine, or organic matter. He then proceeds to point out numerous sources of these materials in different sections of the state, many of which have been brought to light in the progress of the survey.

An extensive bed of marl is pointed out as existing in the northwest part of Stockbridge, in Berkshire county, on land of Mr. Buck, a second in the same town, four miles from the court house in Lenox, a third in the northeast part of Lee, (the thickness of which in some places is ten feet,) also several beds in West Stockbridge. Numerous other beds have also been noticed in the neighboring towns. The purest of these marls when dry, are white and much lighter than the common soil, and they ea-

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* Ann. des Mines, t. xiv, 1838.

sily fall to powder. They abound in small fresh water shells. They contain from 50 to 90 p. c. of carbonate of lime, with considerable organic matter and traces of phosphate of lime; and cannot fail of proving an invaluable application for the adjoining lands.

The clay-beds of the state are described as frequently containing calcareous matter, particularly those which give rise to those curious rounded and flattened concretions, called clay-stones, and which often consist of carbonate of lime in the proportion of 50 per cent. Calcareous diluvium abounds in Springfield, West Springfield, and South Hadley. It consists of the detrital matter from a red slaty rock, which originally contained a few per cent. of carbonate of lime. The lime serves as a cement, and imparts to the aggregate the firmness of a rock; but on being exposed to the weather, it finally crumbles down and in this condition may be conveniently spread upon land.

The composition of the various limestones in the state is also given, from which research it appears that they are chiefly dolomitic. Several new localities are moreover added to the list; and what to us was quite unexpected, two deposites of green sand, one at Marshfield (in a region of granite) and the other at Gay Head. Hydrate of silica, or the light silicious soil which underlies peat-deposits is also used as a fertilizer to some extent in the state, and no doubt with good reason, inasmuch as its animal origin, (having composed originally the skeletons of infusoria,) its impregnation with peat juice, and its favorable mechanical condition, must each contribute to render it highly serviceable.

Prof. H. next points out the sources of geine, or vegetable neutriment with much particularity and good judgment; and finally concludes this part of his subject with the following remarks:

> Though I have dwelt so long upon the analysis and improvement of our soils, it will be seen that I have touched only a few of its more important features, and that even these are but imperfectly considered. Many minor points, of no small importance, however, have been wholly passed over, or only alluded to; and sensible that I cannot do them justice at present, I shall not attempt to discuss them. My great object has been, after ascertaining the greatest deficiences in our soil, to satisfy the Government that we have the means of remedying them and of making great improvements in them, by the aid of chemistry. If I may hope that I have accomplished this object, then I take the liberty to inquire, whether it be not important enough, and whether there is not enough still left to accomplish respecting it, to make the appointment of a *State Chemist* desirable? We ought to have still further experiments made on the subject of geine, and the salts, which the soils

contain : also accurate analyses of the crops grown on soils with different manures; and investigations as to the manner in which calcareous matter acts upon vegetable and animal substances : as also experiments directed by an able and experienced chemist, on the best mode of bringing into use the vast deposites of geine and vegetable fibre which our state contains. And since we have chemists of this character among us, why should not the services of at least one of them be secured for this object? The geological surveyor might often collect substances for analysis; but if obliged to go as thoroughly into the chemistry of the subject as is necessary to valuable results, he cannot within any reasonable time accomplish the more appropriate objects of his appointment. In at least one state of the Union, where geological surveys are in progress, one gentleman is appointed, whose time and attention are exclusively devoted to the chemical examination of the soils, ores, &c., collected. And I would fondly believe, that Massachusetts will not rest satisfied, till this work is done at least as thoroughly as in any other state. I believe there is abundant labor for an experienced chemist upon our soils alone : but many other substances, found in the state, ought to be analysed, that their real value may be known.

Among the secondary considerations relative to the soils of Massachusetts, yet unsupplied in the report for want of time, we presume, are descriptions of the subsoils, (or bottoms on which the cultivable lands immediately rest,) the topographical situations of the soils in respect to a supply of water from springs, lakes and rivers, and accurate tables of the rain-guage and thermometer during the warm season; all of which points are entitled to attention among the elements for determining the agricultural capabilities of a country.

Since the publication of Prof. H.'s first report, the prospect of discovering workable beds of anthracite coal in the region of greywacke where it was predicted to exist, has become strongly heightened. The Mansfield coal company have sunk a shaft to the depth of 84 feet, from which a drift is worked horizontally to a short distance into a bed of coal about ten feet thick. Its specific gravity is 1.79. It consists of carbon 96. alumina, iron, &c. 4. The railroad from Boston to Providence passes within 80 rods of this mine.

No attempts have of late been made to re-work the coal at Worcester, which is situated in an older class of rocks. Its specific gravity is 2.12. It contains water 3. carbon 75. earths and oxides 20.

Small and irregular veins of a very superior bituminous coal are found in the sandstone of the Agawam River in West Springfield. It is in fragments mingled along with calcareous spar and pieces of the sandstone rock, from which circumstance Prof. H.

thinks it may have been formed by sublimation, and accordingly he infers that coal may exist beneath this spot, and that the portions visible have been volatilized by the agency of trap, which rock he supposes, from the situation of the sandstone, lies at a depth of between one and two hundred feet below the bed of the river. If Prof. H. is right in his conjecture, the coal must be reached before the above mentioned depth is attained.

Under the head of ores, we make the following extracts:

1. *Carbonate of iron* at Newbury. Sp. gr. = 2.94. Consists of

| | |
|---|---|
| Carbonate of lime, - - - - | 45.67 |
| " magnesia, - - - | 8.97 |
| " iron, - - - - | 21.76 |
| " manganese, - - - | 16.10 |
| Silica and alumina, - - - | 3.34 |
| Loss, - - - - - - | 4.16 |

It is very abundant.

2. *Magnetic iron* in Warwick. It is very abundant, but is not worked on account of difficulties experienced in its reduction. Sp. gr. = 4.47. Analysis.

| | |
|---|---|
| Oxides of iron, - - - - - | 66.4 |
| Oxide of manganese, - - - - | 16.6 |
| Silica and alumina, - - - - | 17.0 |

3. *Chrome iron ore.* This valuable ore is found in Chester, where it occurs in serpentine, in *couches* from 5 to 18 inches wide. According to Dr. Holland it contains traces of *platinum.*

4. *Limonite* (*Hematite*). This is abundant at several places in Berkshire County, where Prof. H. admits that the beds extend downwards into, and are embraced by the older rocks.

5. *Copperas.* The amount of this annually manufactured at Hubbardston is seventy-five tons.

Several new localities of galena, blende and copper-pyrites are indicated; and the report concludes with brief notices of ochres, clays, water-cement, soap-stone and serpentine-marble.

On the whole, the present work will be found to sustain the character of the more voluminous report by which it was preceded, and cannot fail of advancing the agricultural prosperity of the state, to an elevation corresponding to that which she has reached in the arts and manufactures.

## MISCELLANIES.

### DOMESTIC AND FOREIGN.

1. *Scientific Proceedings of the Boston Society of Natural History in the months of June, July, and August*, 1838; *drawn up from the Records of the Society, by* AUGUSTUS A. GOULD, M. D., *Recording Secretary.*

HE who makes a valuable discovery and refuses or neglects to impart it, robs mankind of a blessing, and himself of the honor that is his due. So it is with scientific bodies. The toilsome and ingenious labors of many an original discoverer, though gratifying to him in their pursuit, gain him no lasting credit; and he will be supplanted by some succeeding aspirant, because he fails to promulgate his discoveries.

None are so likely to have the fruits of their labors usurped as scientific men in America, where the means of disseminating researches are so limited. In view of this, and from the consideration that our members are entitled to the credit of the description of many objects previously unknown to science, the following abstract of its proceedings, in the manner of the "Proceedings of the Zoological Society of London" has been drawn up by the direction of the Society. It is offered for publication, with the intention that, should it receive a place in the American Journal of Science, it should be continued from time to time.

It may be proper, by way of explanation, to say, that it is the custom to commit the objects presented at the semi-monthly meetings to members, who are to report on them at a subsequent meeting. It may be further added, that most of the new species mentioned in this paper, in which only short, specific descriptions are given, are described at length and illustrated by figures in the "Boston Journal of Natural History, Vol. II, No. 2," recently published.

*May* 16, 1838.—GEO. B. EMERSON, Esq., President, in the chair.

Dr. CHARLES T. JACKSON, reported upon some specimens of limestone from the Welland Canal, presented by STEPHEN WHITE, Esq. He showed it to be a carboniferous limestone filled with fossil shells, identical with those in the limestone found on the Aroostic River, Maine; and offered reasons for supposing that there was a continuous bed from Quebec to the Aroostic.

Dr. J. announced that three cases of minerals, collected by him on the public domain in the State of Maine, had been ordered by his Excellency, Gov. EVERETT, to be deposited in our Hall, with the State collection of the minerals of Massachusetts.

Rev. F. W. P. GREENWOOD and Dr. A. A. GOULD, reported upon a paper read at the last meeting by Jos. P. COUTHOUY, Esq., on a species of

Thracia named by him *Thracia Conradi.* It had been previously regarded as *Th. corbuloides*, Deshayes, and is also described and figured by Mr. Conrad as *Th. declivis*, of authors. From the muscular and palleal impressions, the contour and surface of the shell, they were satisfied that it is a new species.

They also reported at some length on the confused synonymy of the different species of the genus *Thracia,* and showed that recent authors, especially Kiener, had increased, rather than diminished, the confusion previously existing.

Rev. Mr. Greenwood reported upon several fruits from Burmah and Siam, recently presented by Rev. H. Malcom. Among them were the Tamarind, (*Tamarindus Indica,*) which is also found in the W. Indies, where it is named *T. occidentalis*, although the differences in the two hemispheres, if any, are very slight; also the *Anona squamosa*, the *sweet sop* of the English, which also grows in the W. Indies.

He also presented the fruit of the *Mamea Americana*, from the nut of which the peculiar flavor of Noyeau is said to be derived.

Mr. Edward Tuckerman, Jr., presented specimens of the *Geaster quadrifidus* of Persoon, and read a paper upon it. He considers it a new addition to the Flora of North America, as Schweinitz, the only person who mentions it, says "nondum Pennsylvaniæ." It was found on the sands beyond Mount Auburn, in company with *G. hygrometricus.* This last is found on the bare sands only; while *G. 4-fidus* is found in firmer earth under trees. The name *4-fidus* is very far from specific, the number of divisions into which it splits being wholly accidental. The specific name, *fornicatus*, Hudson, is better.

At this locality he found more lichens than at any other place of the size, he had ever examined. The reindeer moss (*Cenomyce rangiferina*) here grows to the length of five inches, eight inches being the usual length in Lapland. A large number of species of the genera *Cenomyce* and *Parmelia* are found here, some of the last genus of unusual size and luxuriance.

Mr. J. E. Teschemacher, presented the palatal tooth of the *Ptychodus polygyrus*, Agassiz, an extinct species of shark. The strength and efficiency of these teeth, viewed as instruments for crushing shells and crustacea, are very remarkable. The palatal teeth of this genus are very rare, though the incisor or jaw teeth are common. Only a very few, and most of those imperfect, are yet found in European cabinets. Mr. T. had seen but two in England.

Dr. D. H. Storer read a letter from J. G. Anthony, Esq., of Cincinnati, in which he states that in his researches among the organic remains of that vicinity, *Trilobites with antennæ* occur; and requests the Society to coöperate in the investigation of this curious genus. The letter and subject were committed to Mr. Teschemacher.

Dr. C. G. Page, of Salem, through Dr. Wyman, presented a specimen of Lilium with very extraordinary markings, found in company with *Lilium Philadelphicum*, and probably a variety of that species.

*June* 6, 1838.—G. B. Emerson, Esq., President, in the chair.

Joseph P. Couthouy, Esq., presented two species of Cidaris, and accompanied them with a written paper on the generic distinctions of the Echinodermata, especially on those of the genera Echinus and Cidaris. This paper was rendered peculiarly interesting by the writer's personal acquaintance with the economical value of these animals, and by his amusing description of the manner in which they are served up and devoured on the Mediterranean coasts.

Mr. C. also read a paper on the genus *Patelloidea* of Quoy and Gaimard, (*Lottia* of Sowerby,) a genus which is not to be distinguished from *Patella* by the shell, but in which the animal is very essentially different. His principal object was to show, and to illustrate by living specimens upon the table, that the *Patella amœna* of Say, and *Patella alveus*, Conrad, both belonged to this genus. He conjectured that the *P. cærulea* and *P. pellucida* of Europe, would also be found to come under this genus. He showed that in the animal, the anal and genital orifices are not situated, as stated by Quoy and Gaimard, like those of Patella, just back of the head and near the right tentacula, respectively ; but that they are situated at the bottom of the cervical sac. near the base of the branchiæ. He described a thin, subtriangular, corneous plate, situated perpendicularly on each side of the lingual ribbon, of which he had nowhere seen any mention. He had constantly found it both in Patella and Patelloidea, and thought it should constitute a part of their generic characters.

Mr. W. Whittemore, had found *Planorbis armigerus*, *Cyclas similis*, and *Physa heterostropha* of Say, in a small pond in Cambridge, specimens of which he laid upon the table.

Dr. Jeffries Wyman, made a report upon an anomalous substance resembling bone, recently committed to him. On submitting a definite portion to fire, it gave out the odor of burnt leather, leaving a mass of the same magnitude, but with a loss of 25 per cent. in weight, effervescing with sulphuric acid. He remarked, that although concretions had been found in nearly every cavity of the body, none of so large a size had been found except in the alimentary canal or the urinary organs. Its rough prominences forbade the idea that it was derived from the former, and nothing of an analogous character had been taken from the human urinary organs except in one instance. Its structure was laminated. The only conclusion to which he could arrive was, that it was formed in the animal economy, and probably in the system of some of the lower orders of animals.

Dr. W. also made some remarks upon a skeleton of the sloth (*Bradypus tridactylus*) prepared by himself. The following are some of the peculiarities in its structure, viz. its three toes; its walking upon the side of the foot; the divergence of the posterior extremities from the pelvis; the articulation of the fibula as well as of the tibia with the astragalus; the length of the anterior extremities, so that the fore arm, as well as the hand, is planted upon the ground in walking, so as to bring the body into a horizontal position; the extensive coössification which takes place in all the bones of the hand and foot; the peculiar lateral disposition of the claws, and the source of the deception in President Jefferson's notions of the *Megalonyx*, so philosophically and decisively controverted by Cuvier; the bifurcation of the zygomatic process; and especially the existence of nine cervical vertebræ instead of seven, as found in all other animals. This last point, he observed, was still controverted, it being contended that what appears to be a transverse process only, does in fact bear the rudiment of a rib. Dr. W., however, has been unable to detect any thing like an articulating surface in this specimen, an old one, by long maceration of the bones. The eighth vertebra also has a distinct circular foramen for the vertebral artery, which is the distinctive character of the cervical vertebræ.

Dr. J. B. S. Jackson remarked, that in regard to the transverse process bearing a rudimentary rib, something analogous was found in the human fœtus, the transverse process of the seventh cervical vertebra being a separate piece which afterwards becomes coössified.

Dr. Storer stated, that he had received another letter from J. G. Anthony, Esq., of Cincinnati, communicating the discovery of a new genus of the Trilobite family, and that he had submitted it to Mr. Teschemacher.

*June* 20, 1838.—G. B. Emerson, Esq., President, in the chair.

Joseph P. Couthouy, Esq., began the reading of a monograph of the Family *Osteodesmacea* of Deshayes, embracing the genera *Thracia*, *Anatina*, *Periploma* and *Osteodesma*. He commenced with the genus *Thracia*, and shewed the great confusion which now exists in respect to both the generic and specific characters. This had arisen partly from British writers having confounded the type of the genus, *Anatina declivis*, Pennant, (*Anatina myalis*, Lam.) with another species, *Mya declivis*, Donov. (*Anatina convexa*, Turton,) and more especially by Blainville supposing a shell before him to be *Anat. myalis*, which was not so, but was *Anat trapezoides*, and which he consequently removed from the genus *Thracia* and made it the type of *Osteodesma*, which genus again, he erroneously considers to be synonymous with *Periploma*, Schumacher. Hence have originated numerous other mistakes in subsequent writers. He then endeavored at great length to reconcile the synonymy of the following species, and the following are the results of his research.

THRACIA PUBESCENS, Leach. *Mya declivis*, Pennant, Maton and Rackett, Wood, Dillwyn and Brown; *Anatina declivis*, Brown; *Mya pubescens*, Pulteney, Montagu, and Turton; *Thracia pubescens*, Blainville, Deshayes, Kiener; *Anatina myalis*, Lam., Blainville.

It is believed that this shell has never been found on our coast; the shell which Mr. Conrad supposed to be identical with it, proving, on further examination, to be a distinct species.

THRACIA CONVEXA, Couthouy. *Mya declivis*, Donovan; *Mya convexa*, Wood, Turton; *Anatina convexa*, Turton, (Brit. Biv.,) Brown; *Ligula distorta?* Montagu.

THRACIA CORBULOIDES, Deshayes, Blainville, Lamarck, Kiener.

The exterior surface of the valves is not smooth, as described by Deshayes, unless when the granular asperities have been accidentally effaced.

THRACIA PLICATA, Deshayes, Lamarck, Kiener.

THRACIA PHASEOLINA, Kiener; *Amphidesma phaseolina*, Lam.

THRACIA SIMILIS, Couthouy. Th. testâ ovato-oblongâ, asperâ, albidâ vel cinereâ, subdiaphanâ, inequilaterali, latere postico longiore, truncato et subcompresso, angulo obtuso ab apice ad marginem infero-posticam decurrente; cardine foveolâ subtriangulari, valva utraque ligamento externè prominulo; intus albâ, impressionibus muscularibus anticè elongatis, quasi clavatis, posticè rotundatis; impressio pallii posticè valdè excavatâ; an ossiculum? Length $\frac{22}{40}$, height $\frac{14}{40}$, diameter $\frac{8}{40}$ of an inch. Hab. Coast of Brazil, not far from Rio Janeiro, whence it was brought by a seaman, containing the animal.

In general aspect and its surface it closely resembles *Th. corbuloides*; but it is destitute of the prominent ridge in the centre of the valves, it is much less inequivalve, and its ligamentary apophysis is much shorter, broader and more triangular, and its anterior muscular impression is simple instead of double, as in that species. In outline it approaches to *Th. phaseolina*, but is distinguished by its rough surface and by its very marked striæ of growth.

THRACIA CONRADI, Couthouy. Th. testâ albo-cinerascente, ovato-transversâ, ventricosâ, subæquilaterali, fragili, paullum hiante, margine sinuato, anticè rotundatâ, posticè subtruncatâ, carinâ obtusâ ab apice ad marginem infero-posticam decurrente, ligamento externè prominente, internè callo nymphale valvâ utraque inserto. Length $2\frac{13}{40}$, height $2\frac{4}{40}$, diameter $1\frac{6}{40}$ inches. Inhabits probably the whole coast of New England.

This shell was described and figured by Mr. CONRAD, in his "American Marine Conchology," as *Th. declivis*, under the supposition that it was identical with *Mya declivis*, Pennant; and besides mistaking ours

for the British shell, he has given as synonyms the names of three distinct species. In the "Catalogue of the Animals and Plants of Massachusetts," in Prof. Hitchcock's Report of his Survey of Massachusetts, it is set down as *Anatina convexa*, Wood. In Dr. Storer's excellent translation of Kiener's "Iconographie," it is regarded as identical with *Th. corbuloides*, Deshayes. From this it differs, however, in several important particulars, such as its less elongated form less truncated extremity, smooth surface, and above all in the palleal impression forming posteriorly a deep and almost acute angle instead of the semicircular one of *Th. corbuloides.* The only locality where this shell has been found alive is believed to be Chelsea Beach.

Mr. C. conjectured that *Mya* (Ligula) *distorta,* Montagu, referred by Kiener to *Th. corbuloides,* would prove to belong among the perforating *Corbulæ;* and to these also he was disposed to refer *Anatina truncata*, Turton. Both of them have similar habits of burrowing in the limestone of the British coast.

*July* 18, 1838.—G. B. Emerson, Esq., President, in the chair.

Mr. Couthouy, continued his paper on the *Osteodesmacea,* and made remarks upon the following species.

Periploma trapezoides, Deshayes. *Periploma* inæquivalvis, Schum.; *Anatina trapezoida*, Lam.; *Osteodesma trapezoidalis*, Blainville.

Blainville was led into the error of placing this shell in the genus *Osteodesma* from supposing it to be identical with Lamarck's *Anatina myalis.* But he has committed another serious error in his generic description, which has been adopted by Rang in his "Manuel des Mollusques." He says the shell is "inéquivalve, la valve gauche plus bombée que la droite," whereas the right valve is more convex than the left. Perhaps they were misled by the peculiar position of the ligament, which is remarkable for being placed anteriorly instead of posteriorly, as in most other shells; a fact not noted in any description. In the very perfect specimen under observation the ossiculum is nearly a complete semicircle. Deshayes speaks of it as triangular.

Osteodesma hyalina, Couthouy. *Mya hyalina*, Conrad.

The genus *Osteodesma*, Deshayes, will doubtless prevail over *Lyonsia,* Turton, and *Magdala*, Leach, MSS., all of which are founded on *Mya Norvegica*, Chemnitz, the *Amphidesma corbuloides* of Lamarck. The name is expressive of the distinguishing feature of the shell. Blainville and Rang were led into the error of supposing *Periploma* and *Osteodesma* to be identical; and Deshayes, though he notices the mistake and refers to his article on *Osteodesma* in the Encyc. Method. for its actual characters, yet by a singular oversight that article is entirely omitted. Consequently, it is to be found only in his recent edition of Lamarck. In the "Catalogue of Animals and Plants of Massachusetts, 1834," it is noted

as *Amphidesma corbuloides*, Lam.; but the European shell is twice the size, more elongated, more broadly truncated, more inequilateral, thicker, and covered with a much stronger and more opaque epidermis. Dr. Gould noticed the peculiarity of the ossiculum several years since, and consequently referred the shell to the genus *Lyonsia.*

Mr. COUTHOUY, also read the description of a new species of *Eolis* lately found by him, and which he named

EOLIS DIVERSA. E. corpore limaciformi, posticè acuto, diaphano, luteo-rufescente, capite distincto, sub-orbiculato, depresso; tentaculis gracilibus elongatis duabus instructo, duabusque brevioribus ad partem posticam capitis positis; branchiæ aurantiacæ seriebus binis lateribus dorsi dispositis. Orificia generationis magna, juxta collum ad latus dextrum, ano paullum pone; pede supra laciniato. Length $\frac{24}{2}$, breadth $\frac{7}{20}$ of an inch. Inhabits Massachusetts Bay, Chelsea Beach.

Found among the roots of *Laminaria saccharina.* In its color and general aspect it resembles *E. salmonacea*, Nobis, but differs in the form and position of the tentacula and genitalia. In *E. salmonacea* the lateral tentacula seem to be a prolongation of the fleshy lips, instead of being placed near the neck; the superior ones are long, somewhat compressed, and as it were serrated at the edges, while in *E. diversa* they are short, smooth and round.

Dr. JEFFRIES WYMAN, reported upon a collection of *fossil bones* from the Brunswick canal, Georgia, presented by Mr. Cooper. It consisted of eighteen bones belonging to the genera *Bos*, *Elephas*, and probably *Mastodon.* Among them were the *atlas* of a ruminant, of gigantic size; *metatarsal bone* of right foot of genus *Bos*, about twice the size of the corresponding bone of the common ox which he exhibited by its side, and similar to it in every particular; several *vertebræ* of a *Mastodon;* portions of a *tusk* and *teeth* of an *Elephant.* These teeth resemble those of an Indian elephant, but the layers of enamel are more numerous and closer. An *os calcis* having the hinder portion broken off, but which is now longer than that of our elephant, though not so massive.

Dr. W. had also examined some *fossil bones* brought from Burmah by Rev. H. Malcom. They consist of a portion of the *brim of the pelvis*, probably of a *Mastodon;* tooth exhibiting the longitudinal crescentic layers characteristic of a ruminant, and corresponding with a figure by Mr. Clift in the Trans. of the Geol. Society, vol. vii, of the tooth of a deer from the same locality; *vertebra* of a *Saurian*, also resembling a figure by Mr. Clift, and which he regards as the vertebra of a crocodile, with all probability of truth. This locality on the river Irawaddy, below Ava, is the only locality known where the bones of mammalia and saurians are found associated.

Dr. WYMAN had also examined the recent elephant's tooth brought from Singapore by Mr. Malcom. It indicates greater age than any other tooth on record. The successive teeth have 4, 8, 12, 15, &c. transverse plates of enamel, up to the eighth set which has 23 plates, which is the greatest number heretofore recorded. But this tooth has 26 plates firmly solidified, and some others are broken off from the anterior extremity; indicating a very great age for the animal.

Mr. THOMAS M. BREWER, alluded to a remark at a former meeting when speaking of the cow blackbird. He had said that its eggs could not be hatched by the golden-finch, because that bird had not been observed to breed before the first of August, which is later than the breeding season of the cow blackbird. This remark had nearly proved false. At the latter part of June, Mr. B. had discovered two pairs of finches building their nests, and they had nearly completed them when the weather suddenly became very warm, the nests were deserted and the birds disappeared. As yet, therefore his former remark holds good.

Dr. A. A. GOULD, had examined the marine production presented some time since by Mr. Ballister, and commonly called *Neptune's Goblet*. He had not been able to find any mention of it in Cuvier's Animal Kingdom, or in any scientific work, except in the Asiatic Researches, vol. xiv, p. 180, where it is described and figured by Col. Hardwicke under the name of *Spongia patera*. It is not a true sponge however, although it belongs to the family of sponges It is common in the vicinity of Singapore.

The President, (G. B. EMERSON, Esq.,) read a report on the specimens of paper and pasteboard manufactured from the Beach grass, and presented by its inventor, Mr. Sanderson, of Dorchester. The plant is the *Arundo arenaria*, Lin. It is placed in the genus *Calamagrostis* by Withering and Decandolle, *Ammophila* by Hort and Hooker, *Psamma* by Palissot de Beauvais, Torrey, Eaton and Beck, *Phalaris* by Nuttall. It is called sea-reed or mat-reed, in England, and is found on all the shores from Iceland to Barbary, and all the Atlantic shore from Greenland as far south as New Jersey, at least. Its principal use heretofore has been a negative one, connected with the very terms of its existence. It effectually secures the shifting sands on which it grows; and for that purpose large sums are annually appropriated by government, that by its cultivation important harbors may be preserved.

Mr. E. had not succeeded in finding the ingenious gentleman who had converted the otherwise useless stalks of this plant to so valuable a purpose. The paper is not even, but it is smooth, soft, and pleasant to write upon, and takes ink well. It is firm and very strong, and may be whitened readily. The pasteboard appears to be specially valuable.

Mr. SANDERSON has thus opened a new source for industry to the enterprising inhabitants of the most barren parts of New England; and if he is a benefactor to his race who makes two stalks of grass to grow where

but one grew before, surely *he* deserves well of his country, who indirectly converts barren sands into fruitful fields.

*August* 1, 1838.—Mr. J. E. Teschemacher, in the chair.

After the reading of the records of the preceding meeting, Rev. Mr. Malcom who was present, remarked in relation to the fossils brought by him from Burmah, that they are found only at a small stream below the city of Ava, where the region is perfectly sterile. The soil is clayey, and the bones are very numerous and lie in abundance upon the surface. The place abounds with petroleum wells, and this article is the only product from whence the inhabitants derive their support.

He remarked that the *Spongia patera* was found only at Singapore, and always grows below low water mark, and is fished up by divers.

A specimen of Burman tea was presented by him. It is raised in the interior and compressed into globular masses of four or six inches in diameter, some substance, said to be blood however, being mixed in to cause their cohesion. These are brought to the sea ports on the backs of mules and sold at ten cents per pound. The Burmans use no other tea, and yet Mr. M. found it to be unknown at Calcutta. He pronounced it an excellent tea.

Mr. C. B. Adams, read a paper entitled "Remarks on some species of shells found upon the southeastern shore of Massachusetts." They were the results of his observations in several visits to that region, and contain many interesting facts as to the habits, localities, and varieties, and several important characteristic additions to the original descriptions.

Columbella avara, Say. Differs a little from Say's description; costæ 14 to 18 on the body whorl; young shells are carinate at the termination of the costæ. Found at New Bedford and vicinity, Falmouth, Nantucket, Martha's Vineyard, but not north of Cape Cod.

Buccinum vibex, (Nassa vibex, Say.) Number of revolving lines on the body whorl more frequently 9 or 10; as many as 3 t . 5 teeth on the inner side of labrum. Rare. He had found five specimens about New Bedford. Mr. P. G. Seabury had found others. They are all old and somewhat cretaceous, but in some the rufous bands are distinctly marked. It has not been found north of Cape Cod.

Buccinum trivittatum, (Nassa trivittata, Say.) The two upper bands of rufous are double, being on each side of one of the revolving lines, and the third is often triple; the upper band is darkest, but in many cases the bands from which the species derives its name are wanting. It is generally covered with a dirty cinereous pigment. Abundant at Nantucket, not unfrequent at New Bedford, and occasionally found living at and near Boston.

B. obsoletum, (Nassa obsoleta, Say.) The cancellate and granulated appearance mentioned both by Say and Kiener (*B. oliviforme*) is not a

constant character except in the adult shell; the white band upon the inner side of the labrum is usually well defined. Inhabits not only our estuaries but our ocean shores, though it seems to prefer places not exposed to the surf. The finest specimens grow at Nantucket, where they are abundant. In winter he had observed them to collect together in heaps, filling up slight depressions in the flats.

PURPURA LAPILLUS, Lam. He had not seen this common species at New Bedford, Wood's Hole, or Nantucket; but had found *Fusus cinereus* in situations where he expected to find that species.

RANELLA CAUDATA, Say. Well described by Mr. Say; the canal is not longer than the spire, but equal or shorter. It is rare, and not found north of Cape Cod.

FUSUS CINEREUS, Say. The fauces are not unfrequently white; sometimes there are bands of purplish red in the fauces; the transverse costæ are often nearly obsolete. Generally found clinging to the wet sides of rocks near low water mark.

Mr. ADAMS also read descriptions of the following shells recently discovered by him in the waters of Massachusetts.

JAMINIA SEMINUDA. J. testâ parvulâ, acuto-conicâ, nitidâ, albidâ, sub-translucidâ; anfractibus septem convexis, decusatim granulosis; anfractu postremo infra striato; aperturâ ellipticâ, basi effusâ; columellâ reflexâ, uniplicatâ. Length .15, breadth .07 inch. Inhabits Dartmouth harbor.

Only four specimens were found, about five feet below low water mark, on valves of *Pecten concentricus*. In size and figure it resembles *Actæon trifidus*, Totten, but differs in its convex whorl, granulous surface, and more distinct and uniform revolving lines; also in its less rounded and more effuse aperture.

PYRAMIS FUSCA. P. testâ parvulâ, conicâ, decisâ; epidermide fuscâ, nitidâ; anfractibus sex, convexis; suturâ impressâ, sub-duplicatâ; aperturâ ovali, supra angulatâ, infra rotundatâ; labro tenui; columellâ convexâ, reflexa, haud duplicatâ. Length .15 inch, breadth .07 inch. Inhabits harbors of New Bedford and vicinity.

CERITHIUM EMERSONII. C. testâ parvâ, conicâ, elongatâ, longitudinaliter rugosâ, lineis granulatis cinctâ; anfractibus septemdecim, planulatis; apice acutâ; suturâ sub-impressâ, amplâ; aperturâ sub-quadratâ; labro pectinato; columellâ in spiram ductâ; caudâ recurvatâ. Length .45 inch, breadth .12 inch. Inhabits New Bedford harbor on the Fairhaven side, and Nantucket (?). A variety has the granules obsolete, or coalescing into simple elevated, revolving lines.

CERITHIUM NIGROCINCTUM. C. testâ parvulâ, conico-cylindricâ, granulosâ, nigro-rubra; anfractibus tredecim, sinistrorsum volventibus; spirâ elongatâ, acutâ; suturâ sub-duplicatâ; aperturâ sub-ellip-

ticâ, parvâ; caudâ recurvatâ. Length .3 inch, breadth .08 inch. Inhabits Dartmouth harbor, clinging to sea-weed.

Differs from *C. perversum*, Lam., in the black sutural ridge, and in the position of the middle series of granules; and from *Murex adversus*, Montagu, in its recurved canal, its distinct suture and its color.

Mr. Couthouy concluded his paper on the Osteodesmacea, and also instituted a new genus to include shells formerly embraced in genus *Anatina*, but which, having a spoon-shaped hinge, are destitute of an ossiculum. He thus characterized it.

### Genus Cochlodesma.

*Animal* oval, compressed, enveloped in a thin mantle, closed by a membrane in front, except at the anterior inferior extremity, where it opens to give passage to a broad compressed foot, extending along the whole inferior surface of the abdominal mass, which is inconsiderable; edges of the pallium thickened, and a little rugose; siphons long, slender, divided in their whole extent, and opening separately into the branchial cavity.

*Shell* transversely oval, thin and fragile, sub-equilateral, convexo-depressed, slightly gaping at both extremities, inequivalve, right valve more convex, beaks moderately prominent, inclining a little backwards, summits cloven and sub-nacrous posteriorly; extremities rounded. Ligament double, the external very slight and membranous, the internal received into a horizontal, spoon-shaped process on each valve, supported by one or two divergent falciform costæ, projecting from it obliquely and posteriorly; muscular impressions superficial, remote, the anterior elongated-oval, the posterior small and sub-triangular, united by a palleal impression profoundly indented posteriorly.

The *Anatina Leana*, Conrad, is the type of the genus; and the *Anatina prætenuis*, Turton, probably belongs to it.

Mr. Couthouy then read descriptions of the following new species of shells.

Nucula navicularis. N. testâ parvâ, lævi, fragili, ovali, sub-æquilaterali, luteo-virescente, anticè rotundatâ, posticè truncatulâ, cardine dentibus octodecim, intus albo-nitescente. Length $\frac{1}{2}\frac{1}{0}$, height $\frac{5}{2}\frac{}{0}$, breadth $\frac{3}{2}\frac{}{0}$ of an inch. Inhabits Massachusetts Bay, vicinity of Plymouth.

Beaks more central and basal outline much more strongly curved, than in *N. myalis*, Couth.

Bulla lineolata. B. testâ parvulâ, oblongo-ovatâ, ferrugineâ, transversim obliquè frequenterque striatâ, spirâ, prominulâ, apertura magnâ, ad basim valdè dilatatâ et sub-effusâ. Length $\frac{6}{4}\frac{}{0}$, breadth

$\frac{3}{40}$ of an inch. Inhabits Massachusetts Bay. Taken from a fish's stomach taken off Race Point, and resembles *B. lignaria* in miniature.

BULLA HIEMALIS. B. testâ perparvâ, hyalinâ, globosâ, convolutâ, longitudinaliter tenuè striatâ, spirâ nullâ, aperturâ ad basim valdè dilatatâ. Length $\frac{1}{10}$ of an inch, breadth about the same. Inhabits Massachusetts Bay.

BULLA GOULDII. B. testâ parvâ, ovatâ, convolutâ, fragili, albâ, transversim tenuè striatâ, spirâ depressâ, imperforatâ, interdum prominulâ, anfractibus quatuor, supernè rotundatis, suturis impressis, aperturâ supra angustâ, versus basim dilatatâ, columellâ arcuatâ. Length $\frac{11}{40}$, diameter $\frac{5}{40}$ of an inch, nearly. Inhabits Massachusetts Bay. In size and shape much like *B. insculpta*, Totten, but is smoother, more solid and not umbilicated. Often the outer volution forms an elevated, rounded ridge, encircling and rising above the others.

PLEUROTOMA DECUSSATA. P. testâ parvulâ, ovali, fusiformi, albidâ, anfractibus quinque convexis, longitudinaliter plicatis, transversè striis frequentibus tenuibus decussatis, aperturâ elongato-ovali, basi sub-canaliculatâ, labro tenui, lævi, supernè indentato, columellâ nitidâ, depressâ arcuatâ, ad basim sinistrorsum divergens. Operculum rudis. Length $\frac{7}{20}$, diameter $\frac{3}{20}$ of an inch. Inhabits Massachusetts Bay. Distinguished from *Fusus harpularius* by its color, the greater convexity of the whorls, and the angular sinus at the junction of the lip.

ANCULOTUS DENTATUS. A. testâ rotundata vel sub-conicâ, irregulari, olivaceo-nigrescente; anfractibus quinque, ultimo magno, ventricoso, sæpe fasciis duobus aut tribus radiis cincto; suturis impressis, spirâ obtusâ plerumque erosâ; aperturâ erosâ, basi effusâ; columellâ atrâ arcuatâ, depressâ, ad basim unidentatâ, posticè excavatâ, intus virido vel fusco-albescente. Operculo corneo, unguiculato. Length $\frac{10}{40}$, diameter $\frac{11}{40}$ inch. Inhabits the rapids of the river Potomac, Va.

Greatly resembles *A. monodontoides*, Conrad, but is distinguished by the peculiar flattening of its purple columella, the remarkable fossa in the umbilical region, and its more obtuse tooth situated nearer the base.

Dr. T. W. HARRIS, made some remarks on the difficulties met with by himself and others in the study of Botany, on account of the want of strict accuracy in our books. Thus, in Bigelow's Florula, *Vaccinium* is placed in Octæandria, while all our species are invariably 10-androus, and are so arranged in all more recent works. *Menyanthus* has the stigma trifid oftener than bifid, and sometimes quadrifid. *Chelidonium*, which belongs to Polyandria, has only 8 to 12 stamens; while *Cratægus*, which belongs to 20-andria, is found with only 10 stamens.

Dr. H. had recently found a *Silene* growing on earth thrown out from a newly dug drain, and had since observed it on the corn-fields, near by. It proves to be *Silene noctiflora*, Sowerby. It flowers in the evening, and Mr. Sowerby says the same flowers open for several successive evenings until they are impregnated. Do H. nds this to be not true. Eaton says the teeth of the calyx tube are equal; but they were alternately longer and shorter. This plant may be considered as naturalized among us.

Beck pronounces the *Lathyrus maritimus*, Bigelow, to be *Pisum maritimum*; but Dr. H. is confident that Dr. Bigelow is correct.

Mr. A. A. Hayes, presented a specimen of native nitrate of soda from Tamarugal in Peru. It contains sulphate of soda, chloride of sodium, *Iodate of soda*, and chloriodide of sodium. In presenting this specimen with its analysis, Mr. Hayes makes the first public announcement of the discovery of *Iodate of soda*, as a new chemical species.

Mr. C. B. Adams, enumerated the minerals in the collections from California by Mr. Kelly, and from Nova Scotia by Rev. Mr. Prior, and made various remarks respecting them, to designate their peculiarities and value.

*August* 15, 1838.—Dr. T. W. Harris, in the chair.

Dr. Jeffries Wyman, exhibited a fœtal kitten contained in its membranes, showing the peculiar manner in which the placenta encircles the fœtus like a zone. Also the uterus of a mouse, showing its bead-like appearance when impregnated. Also the egg of the snapping turtle near the close of incubation, showing the passage of the umbilical vessels through a hole in the sternum. These are finally cut off and the aperture closed by a peculiar muscle.

Mr. T. M. Brewer, remarked further on the goldfinch alluded to at a preceding meeting;—that on 22d July he again observed the bird at its nest, where there were four eggs. This was three weeks earlier than usual, and the cow-bunting leaves us three weeks earlier still.

Mr. E. Tuckerman, Jr., presented some plants not yet catalogued, as belonging to this country, they were *Cladonia vermicularis*, *Cetraria nivalis*, and a *Parmelia*, all from the White Mountains.

Dr. T. W. Harris read a paper entitled "Remarks on the N. American insects belonging to the genus *Cychrus* of Fabricius, with descriptions of some newly detected species." He proceeded to show that the genus *Scaphinotus*, Dejean, is established on very insufficient characters. Those of *Sphæroderus* are somewhat better. The same also with Mr. Newman's genus *Irichroa*. He concludes that the insects placed in *Cychrus*, *Sphæroderus*, *Irichroa* and *Scaphinotus*, are more closely related to each than to any other genus, and can constitute merely subgenera.

The following are the new species:

Cychrus Andrewsii. Black; thorax deep greenish blue, heart-shaped, narrowed behind, and slightly margined at the sides; elytra deep blue,

faintly tinged with violet, slightly carinated at the base and sides, and with punctured striæ. Length, including the mandibles, nine and a half lines. Inhabits North Carolina. Resembles *C. marginatus* and more nearly still *C. cristatus* from Oregon.

Cychrus Leonardii. Black; head transversely striated; thorax violaceous, subquadrate, narrowed behind; elytra broad ovate, carinated at the sides, bronzed violet, deeply crenato-striated. Length, including mandibles, from 11 to 13 lines. Inhabits northern and western parts of Massachusetts and New Hampshire. Hitherto confounded with *C. viduus*, from which it essentially differs in color and its more dilated form.

Cychrus tuberculatus. Black opaque; head rugose and with two longitudinal impressions on the front; thorax rugose, truncato-cordate, contracted behind; coleoptra ovate, very convex, granulated, with a triple series of smooth tubercles on each elytron; epipleura rugosely punctured. Length 7 to 8¼ lines. Inhabits Oregon.

Cychrus angulatus. Black; head carinated; thorax angulated at the sides, much contracted behind; elytra violaceous-brown, somewhat flattened, crenulato-striate; legs brownish-piceous. Length 6½ lines. Inhabits Oregon.

Cychrus cristatus. Black; head carinated; thorax cordate, contracted behind; elytra crenato-striate, with a narrow, blue margin. Length 5¼ lines. Inhabits Oregon.

Dr. Harris exhibited specimens of *Nymphea odorata* (var. sanguinea) from the Botanic Garden, Cambridge; and remarked upon the tendency, strongly exhibited in these specimens, which all the parts of the flower have, to become leaves.

Dr. Gould remarked that this lily was originally brought from Mossy Pond, in Lancaster, where it grows in one small spot. He was inclined to regard it as a distinct species, having constantly found the angles of the leaves more prolonged, the color darker and the size smaller than in *N. odorata.*

Mr. C. B. Adams, had spent a day at Fresh Pond, and gave an account of the shells he had found there. They were the following species, viz.: *Unio nasutus*, *complanatus*, and *radiatus*; *Anodonta implicata*, Say; *Cyclas similis*; *Planorbis trivolvis*, *bicarinatus*, *deflectus?* and *hirsutus*, MS.; *Valvata tricarinata*; *Succinea ovalis*; *Lymnea heterostropha*, *columellaris*, *catascopium*, *Physa heterostropha*, *Paludina decisa*, *lustrica?*

Of *Unio nasutus* only one specimen was found, *U. radiatus* was abundant, clean and beautiful. From one of them dropped a beautiful pearl in the form of a flattened sphere, .16 inch in the longer and .11 inch in the shorter diameter. Of *Anodonta implicata*, Say, he said, that a comparison of adult shells only, with specimens of *A. cataracta* from other localities might lead to the conclusion that they were distinct species; but an examination of them in every stage of growth from the size of the

thumb nail upwards, renders it probable that they are only a variety of *A. cataracta.* An undescribed species of *Planorbis* was found abundantly. He first found it in Mansfield, and it has since been found by Dr. Gould in Dedham, and he proposes to describe it under the specific name *hirsutus.* It resembles the European *albus* in the revolving lines of hairs by which it is covered. A minute species of *Paludina* seems also to be new.

2. *African Meteorite.*—(*From the London Nautical Magazine.*)—Extract from a letter, dated Nov. 24, 1838, written by a gentleman (on whom reliance may be placed) residing at the Cape of Good Hope. "I have taken the liberty to transmit under your charge, for Sir John Herschel, the accompanying aërolite, another portion of an enormous aërolite, that exploded in the department called the Cold Bokkeveld, about 112 miles N N. E. of this place, on the morning of the 13th October, (1838,) and which for magnitude ranks with the largest on record of undoubted authority. Judge Menzies, returning from circuit, saw it traversing the atmosphere about 60 miles from the estate, where it exploded with a report equal to the discharge of some heavy pieces of artillery, to the great astonishment of the inhabitants, one of whom had a narrow escape from being destroyed by it. I am making strong efforts to secure a piece, said to have made a hole in the ground that would admit a dining table! This may be exaggerated. A man declares the hole is three feet in diameter. Also to collect information regarding its velocity, course, altitude, &c."

3. *New species of Argulus; notice from Dr. T. W. Harris.*—It may interest some of your readers to be informed of the discovery of another species of ARGULUS in this country. It was found in the gills of a herring, caught upon Brighton bridge from Charles river, during the month of June last. It differs from ARGULUS *foliaceus* of Europe, and from the species described in a former number of your Journal, vol. xxxiv, p. 225, in the size and form of the body, and in the shortness of the legs. Having presented the specimen to Dr. A. A. Gould, for description, I shall not attempt to anticipate him by giving a detailed account of its specific characters at this time.

Cambridge, (Mass.) Feb. 8, 1839.

4. *Cabinet of Minerals for sale.*—The Cabinet of Minerals of the late Dr. Young, of Edenville, N. Y., is offered for sale. This collection was selected with great care by Dr. Young, and embraces the rare and beautiful productions of Orange county, N. Y., and Sussex county, N. J. Its crystals of spinelle, corundum, Franklinite, Brucite, Troostite, melanite, hornblende, bronzite, idocrase, &c., &c., would be an invaluable acquisition to any public cabinet. It has been generally pronounced by min-

eralogists to be one of the most select and beautiful collections ever formed in this country.

Edenville, April 12th, 1839.

5. *Correction.*—In Vol. xxxv, No. 2, p. 375, we mentioned the supposed spontaneous crystalization of liquid carbonic acid in one of Dr. Torrey's tubes. In a letter from him dated New York, March 1, it is remarked that the crystals which we had observed were sulphate of ammonia, which was formed by the combination of sulphuric acid with ammonia during the decomposition of the carbonate to obtain the carbonic acid gas for condensation. He adds, "a very good method of showing the rapid condensation of the carbonic acid, and its *ebullition* at the same time, is to surround the upper part of the tube with a freezing mixture. Place the mixture (ice and salt) in a bottle, the bottom of which is cut off. The mouth is furnished with a perforated cork, through which the upper part of the tube is thrust.

"I have been shooting with a kind of air gun, using my liquified carbonic acid for throwing the balls, and I hope soon to emulate Perkins' steam gun."

6. *Footsteps and Impressions of the Chirotherium, and of various Animals, in sandstone.*—The readers of this Journal are familiar with the reports made by Professor Hitchcock, on the foot marks of birds and perhaps quadrupeds upon the sand stone rocks of the valley of the Connecticut River. See vol. xxix, p. 307, and vol. xxxii, p. 174. We have cited also those observed ten years ago at Corncockle Muir in Scotland, vol. xv, p. 84; and more recently near Hildburghausen, in Germany, vol. xxx, p. 191.

We shall now, from the reports of the doings of the Geological Society of London, cite some other facts of this class. We allude to the now famous quarries of Storeton Hill, near Liverpool, England.

We have recently received from Prof. Buckland fine copies of these impressions, and it is no more possible to doubt the genuineness of their originals, than those of the most recent impression of a foot made in any yielding surface of the present hour. The same is true of the impressions of Prof. Hitchcock, whatever doubt may have been felt by some persons who have never examined them.

The communication which we now cite was made to the Geological Society by the Natural History Society of Liverpool, with drawings by John Cunningham, Esq.

In the early part of last June, there were discovered in the Storeton quarries, on the under surface of several large slabs of sandstone, highly relieved casts of what the workmen believed to have been human hands; and the circumstance having been made known to the Natural History Society of Liverpool, a committee was appointed, who drew up the report communicated to this Society.

The peninsula of Wirral consists of new red sandstone; and towards the northern extremity, the formation may be separated into three principal divisions. The lowest is composed of beds, slightly inclined towards the east, of red or variegated sandstone, occasionally abounding with pebbles partly derived from the coal-measures; and in the bottom strata either angular or little water-worn. Seams of marl are very rare in this division, the argillaceous matter being confined to nodules or concretions of clay of the same color as the sandstone.

The middle division consists of white or yellow sandstone, in some places argillaceous, and frequently containing round concretions of clay, and pebbles. The strata are separated by seams of white or mottled clay, occasionally almost imperceptible, but sometimes several inches thick.

The uppermost division is formed of red or variegated sandstone, inclosing also nodules of clay and pebbles of quartz; and it abounds with strata of red marl.

The Storeton quarries are situated in the middle division; and the casts which have hitherto been noticed, occurred on the under surface of three beds of sandstone, about two feet thick each. The strata incline 8° to the northeast, but they are traversed by several faults, which range in the strike of the beds. The authors of the report are of opinion, that each of the thin seams of clay in which the sandstone casts were moulded, formed successively a dry surface, over which the Chirotherium and other animals walked, leaving impressions of their footsteps; and that each layer was submerged by a depression of the surface. The lowest seam of clay was so thin, that the marks penetrated into the subjacent sandstone. The following account is then given of a hind foot and a fore foot, selected from slabs in the Museum of the Royal Institution, Liverpool.

*Hind Foot*, consisting of five digits; one of which, from its resemblance to a human thumb, has been generally distinguished by that designation.

| | Inches. |
|---|---|
| Total length from the root of the thumb to the point of the second toe . . . . . | 9 |
| Extreme breadth from the point of the thumb to the point of the fourth toe . . . . . | 6 |

| | Inches. |
|---|---|
| Breadth across the toes | 5 |
| Breadth across the palm | 3 |
| Length of the curved line extending from the root of the thumb to its point | $6\frac{1}{2}$ |
| Breadth of the ball of the thumb | $1\frac{1}{2}$ |
| Relief of the ball of the thumb from the surface of the slab | $\frac{1}{2}$ |
| Length of the first toe from the root to the point | $5\frac{1}{4}$ |
| Length of the second ditto | $5\frac{1}{2}$ |
| Length of the third ditto | 4 |
| Length of the fourth ditto | $2\frac{1}{2}$ |
| Average breadth of the first three toes | 1 |
| Average breadth of the fourth toe rather less than | 1 |
| Relief of the second toe, which presents the greatest prominence | $\frac{6}{10}$ |

One hind foot has been observed which measured 12 inches in its greatest length.

Judging from the appearance of the casts, the sole of the foot must have been amply supplied with muscles, the casts of the ball of the thumb and the phalanges of the fingers being prominent. The digit which has been called a thumb, is of a tapering shape, and is bent backwards near the extremity, where it ends in a point. It is extremely smooth, and there is no satisfactory evidence of either a nail or a claw. The toes are thick and strong, and had probably three phalanges each, and at the terminations are traces of stout, conical nails or claws. The sole of the foot is supposed to have been covered by a slightly rugose skin, the folds of which are stated to be distinctly visible in the casts of the toes.

*Fore Foot.* Perfect impressions of the fore feet are extremely rare, owing either to the animal having used those feet lightly, or to the impressions having been obliterated by the tread of the hind feet. The best preserved cast exhibits a thumb and three toes, being deficient of the fourth. The dimensions, which are generally half of those of the hind foot, are as follows:

| | Inches. |
|---|---|
| Length from the root of the thumb to the point of the second toe | $4\frac{1}{2}$ |
| Total breadth not ascertained in consequence of the absence of the fourth toe | |
| Breadth of the palm | $1\frac{3}{4}$ |
| Length of the thumb | $2\frac{1}{2}$ |
| Breadth of the ball of the thumb | 1 |
| Length of the first toe | 2 |
| Length of the second toe | $2\frac{1}{4}$ |
| Length of the third toe | $2\frac{1}{4}$ |
| Greatest breadth of the toes | $\frac{3}{4}$ |

The thumb is slightly bent back, and pointed, and the toes were armed with nails.

Traces of one animal have been observed in a continuous line on a slab ten yards long. The length of the step varies a little, but in general, the distance between the point of the second toe of one hind foot and the point of the same toe in the hind foot immediately in advance, is between 21 and 22 inches. Each fore foot is placed directly in front of the hind, and the thumbs of both extremities are always towards the medial line of the walk of the animal. Some further observations are given by the authors with respect to the progression of the animal, on the supposition that the digit conjectured to be a thumb, was rearly the first. Conceiving such to be the case, they state, that the animal must have crossed its feet three inches in walking, for the right fore and hind feet are placed $1\frac{1}{2}$ inch on the *left* side of the medial line, and the left fore and hind feet $1\frac{1}{2}$ inch on the right side of the same line.

The casts of the Chirotherium, although the most remarkable, are by no means the most numerous, which exist on the Storeton sandstones. Many large slabs are crowded with casts in relievo, some of which are supposed to have been derived from the feet of saurian reptiles, and others from those of tortoises. Occasionally the webs between the toes can be distinctly traced. "It is impossible," say the authors of the report, "to look at these slabs and not conclude, that the clay beds on which they rested, must have been traversed by multitudes of animals, and in every variety of direction."

A note by Mr. James Yates was then read, giving a brief account of sketches of four differently characterized footsteps, traced from casts procured at Storeton, each of which is distinct both from the casts of the Chirotherium and the web-footed animal mentioned in the preceding report.

A paper was afterwards read "On two Casts in Sandstone of the impressions of the Hind Foot of a gigantic Chirotherium, from the New Red Sandstone of Cheshire," by Sir Philip Grey Egerton, Bart., M.P., F.G.S.

These specimens first came under the notice of Colonel Egerton, about 1824, and they were placed in the author's cabinet in 1836; but it was not until the recent discovery of the Chirotherium at Storeton, that their true nature was suspected. The exact locacity, at which the specimens were discovered, is not known; but it is probaable, that they were obtained from the neighborhood of Colonel Egerton's residence, near Tarporley, and from one of the beds of sandstone, which alternate with the red and green marls in the upper part of the new red system in that part of Cheshire.

The casts, which consists of a rather soft and coarse sandstone, were evidently formed in the impressions of two hind feet; and though they have suffered from exposure to the weather for twelve years, yet they are sufficiently perfect to have enabled Sir Philip Egerton to take the measurements of the different parts, and draw up the accompanying comparative table. It is necessary to state, that though he preserves the use of the term thumb for the convenience of comparison with previous descriptions, yet he is of opinion that the marginal digit which has been so designated, is not the representative of the fifth, but of the first toe.

| Direction of the Measurements. | Hessberg Chirotherium. | Storeton Chirotherium. | Large Chirotherium from near Tarporley. |
|---|---|---|---|
| Length from the heel to the point of the 2nd toe - - - | 7 8 .. | 8 7 .. | 15 0 |
| Length from the heel to the point of the thumb - - - | 3 4 .. | 4 3 .. | 8 0 |
| Length from the heel to the angle between the 1st and 2nd toes - - | 4 8 .. | 5 6 .. | 10 0 |
| ——————— 2nd and 3rd toes | 4 4 .. | 5 8 .. | 11 0 |
| ——————— 3rd and 4th toes | 4 0 .. | 5 3 .. | 11 0 |
| Greatest breadth across the insertions of the toes - - - | 5 0 .. | 4 2 .. | 8 5 |
| Breadth from the point of the thumb to 4th toe - - - | 5 5 .. | 5 0 .. | 9 0 |
| Breadth from the thumb to point of 4th toe | 6 3 .. | 6 0 .. | 10 6 |
| Breadth across the sole below the thumb | 3 6 .. | 3 0 .. | 6 0 |
| Breadth from 1st toe-point to 4th toe-point | 4 6 .. | 4 6 .. | 9 0 |

From these measurements it appears, that considerable differences exist in the three specimens of Chirotherium. Upon comparing the footstep from Hessberg with that from Storeton, it will be found, that the former is thicker and more clumsy than the latter; that the sole is shorter and broader, and the toes wider and longer. The most important discrepancy, however, is in the position of the thumb, which is placed much nearer the heel in the Hessberg specimens than in those from Storeton. The cast from near Tarporley resembles the latter more than the former; it nevertheless differs considerably in the proportion of the breadth to the length of the sole, which is greater; and in the proportions of the length of the toes to the length of the sole, which is less than in the Storeton specimens. It is also distinguished by the greater divergence of the toes from each other. From these differences and the gigantic size of the Tarporley specimen, the author conceives that the animal which made the impression was a distinct species; and he proposes for it, in compliance with the adage *ex pede Herculem*, the name of *Chirotherium Herculis*.—*Lond. and Edin. Phil. Mag., Jan.*, 1839.

## 7. *New Works received.*

From motives of convenience we have omitted, on the present occasion, our usual list of acknowledgments; but we are unwilling to postpone the mention of the following works, which have been presented since our last number.

1. Geological Report on the State of New York, continued from last year, being State Document, No. 275; communicated to the Legislature of the State, by Gov. Seward, Feb. 27, 1839. pp. 351. Copies from L. Vanuxem, E. Emmons, and B. D. Silliman.

2. Geological Report on the State of Michigan in continuation, Doc. No. 23, Feb. 4, 1839, by Douglass Houghton, State Geologist. pp. 123. From A. Sager, and a second copy to the Yale Nat. Hist. Society.

3. Second Annual Report on the Geological Survey of the State of Ohio, by W. W. Mather, and several assistants. Columbus. 1838. From C. B. Goddard, Esq.

4. First and Second Annual Reports on the Geological Survey of Virginia, for 1836 and 7, by and from Prof. Wm. B. Rogers. Univ. Virg. pp. 87.

5. Report on the Geological Survey of Virginia, Doc. No. 56, in continuation, for 1838, by and from Prof. Wm. B. Rogers. Univ. Virg. pp. 32, quarto.

6. Annual Report of the Geologist of Maryland. 1838. pp. 33.

7. Report on the Geology of Indiana, 1837–8, by D. D. Owen, State Geologist. pp. 54.

8. Third Annual Report of the Geological Survey of Pennsylvania, by and from Prof. H. D. Rogers, State Geologist. 1832. pp. 118.

9. Trans. Am. Phil. Soc. Phil. Vol vi, Part I. 1838. p. 152. From the Society.

10. Third edition in quarto of the catalogue of shells in the collection of Dr. John C. Jay, N. Y., 1839. 2 copies. From the author to B. Silliman, Jr., and to the Yale Nat. Hist. Society.

11. The Silurian System founded on Geological Researches in the counties of Salop, Hereford, Radnor, Montgomery, Caermarthen, Brecon, Pembroke, Monmouth, Gloucester, Worcester,

and Stafford, with descriptions of the coal fields and overlying formations, by Roderick Impey Murchison, F. R. S., F. L. S., Vice President of the Geological Society of London, &c. &c. &c., in two parts. Part I, containing over 600 pages, large and full quarto, illustrated by 112 wood cuts and a map; with 13 picturesque views, generally colored, and several of them folded. Part II, Organic Remains and Sections, over 200 pages quarto, making more than 800 for the entire work. There are 27 lithographic plates for the organic remains, containing nearly 700 figures.

The colored sections are nine, generally three folded, and containing 111 distinct sub-sections.

The country described by the author, after seven years of arduous exertion among the mountains and in the cabinet, is represented on a splendid colored map of five feet by three, after the three sheets of which it is composed are duly joined. At the bottom of this map is an ideal colored section, representing all the rocks which are described by Mr. Murchison.

For this magnificent work we are indebted to the accomplished author, who has achieved a signal triumph for British Geology and for the science itself.

12. Seventh Report of the British Association for the advancement of science, Vol. vi, pp. over 700—over 500 for the general meeting, and about 200 for the sections, &c. &c.,—illustrated by thirteen plates and maps, several of them folded. From the Association.

13. British Annual and Epitome of Science, for 1839, edited by Robt. D. Thomson, M. D. From the editor.

14. Annual Reports for 1838 and 9, of the Royal Institution of Civil Engineers London. From the Institution.

15. Journal of the Statistical Society of London, for 1838, January to December inclusive—except August. From the Society through R. K. Kennett, Covent Garden.

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